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AVIATION WEEK

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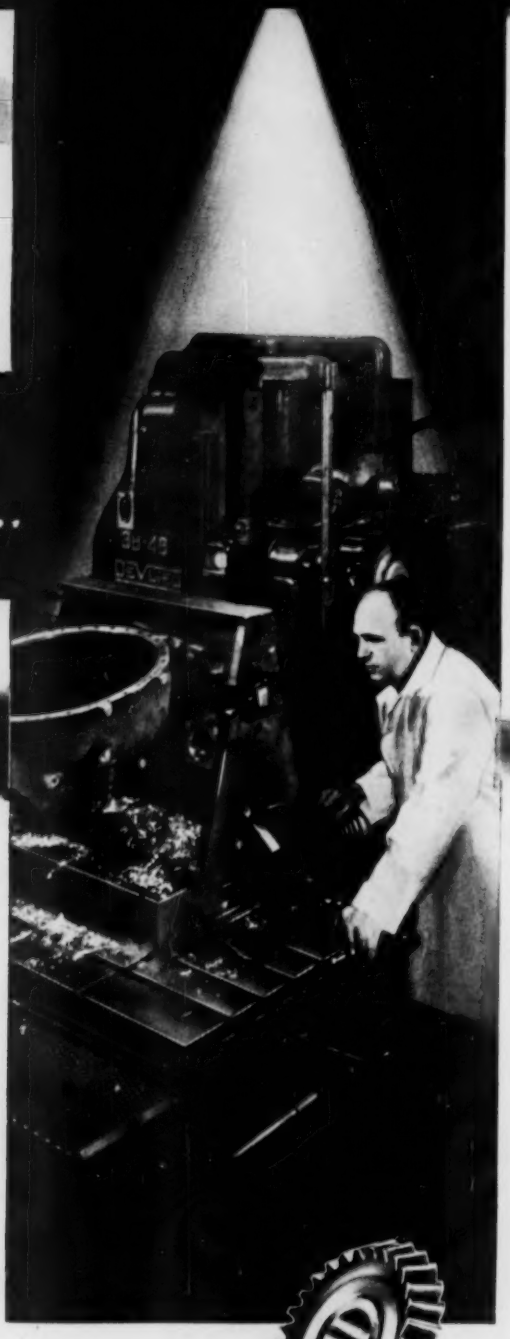
German Orders Are Best SR.177 Hope

•

Company Builds on Solid Propellants

Laboratory Frost Coats F-105

he's watching the progress of the Air Age from his machine . . .



Piston engines . . . jets . . . and now, missiles, Foote Bros. craftsmen are watching the steady advance of American air progress from their machines. They're not only watching it—they are an important part of it, because, at this moment they are helping produce components capable of performance undreamed of a short time ago.

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Now the other has been selected by Boeing for jet transport service.

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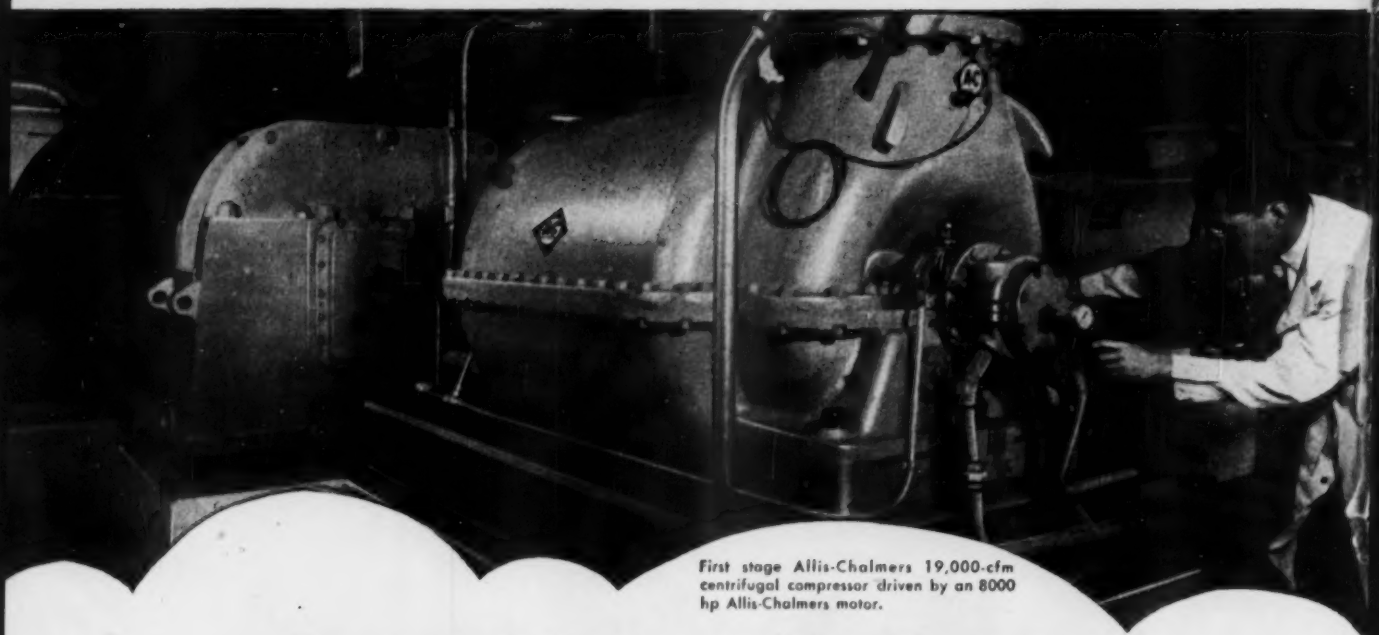
Iceguard – T. M. The Goodyear Tire & Rubber Company, Akron, Ohio

Compressors for new Convair wind tunnel for testing designs to Mach 5



First stage Allis-Chalmers 19,000-cfm centrifugal compressor driven by an 8000 hp Allis-Chalmers motor.

Uses combination of Allis-Chalmers compressors, motors, switchgear, control

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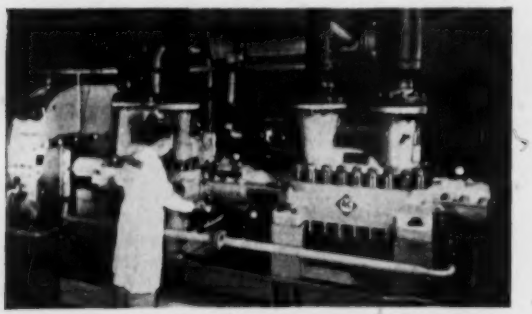
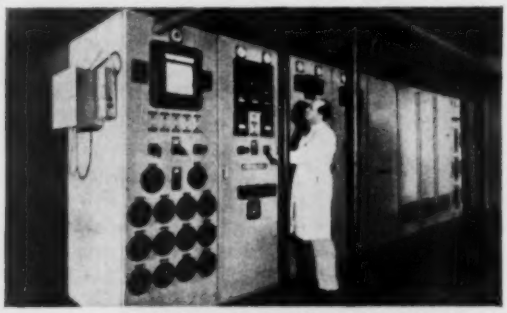


Second and third stage centrifugal compressor driven by the some 8000-hp motor.



Allis-Chalmers also supplied switchgear and control for power distribution and protection.

Chicago Bridge & Iron Co., Prime Contractor
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Convair, a Division of General Dynamics Corporation

ALLIS-CHALMERS

A-5376

AVIATION CALENDAR

Jan. 6-8—Fourth National Symposium, Electronics Reliability and Quality Control, Hotel Statler, Washington, D. C.

Jan. 9-10—Meeting of Airlines Proximity Warning Indicator & Air Collision Avoidance System Committee, Hollywood-Roosevelt Hotel, Los Angeles, Calif. Open to public only Jan. 9. Those wishing to make presentations must write to Air Transport Assn., Washington, D. C., by Dec. 20.

Jan. 13-15—10th Annual National Convention, Helicopter Association of America, Western Hills Inn, Dallas-Ft. Worth.

Jan. 13-17—1958 Annual Meeting, Society of Automotive Engineers, Sheraton-Cadillac and Hotel Statler, Detroit, Mich.

Jan. 13-May 14—Lecture series on Space Technology, sponsored by University of California and Ramo-Wooldridge Corp., to be held in Los Angeles, San Diego and San Francisco. For details write: University of California Extension, Dept. of Conferences and Special Activities, Los Angeles 24, Calif.

Jan. 14-15—Yankee Instrument Fair & Symposium, sponsored by Instrument Society of America (Boston, Connecticut Valley and Fairfield County Sections), Hotel Bradford, Boston, Mass.

Jan. 18-31—14th Annual Technical Conference, Society of Plastics Engineers, Sheraton Cadillac Hotel, Detroit, Mich.

Jan. 20—Winter Meeting, Provisional Western States Section, The Combustion Institute, California Institute of Technology, Pasadena, Calif. For details write: Mr. G. S. Bahn, Marquardt Aircraft Co., Van Nuys, Calif.

Jan. 20—"Information Theory and the Communications Engineer," speaker: Dr. Marcel Golay, consultant, Physical Sciences Auditorium, University of Pennsylvania, Philadelphia.

Jan. 20-21—First Annual General Meeting, Association of Local and Territorial Airlines, Washington Hotel, Washington, D. C.

(Continued on page 6)

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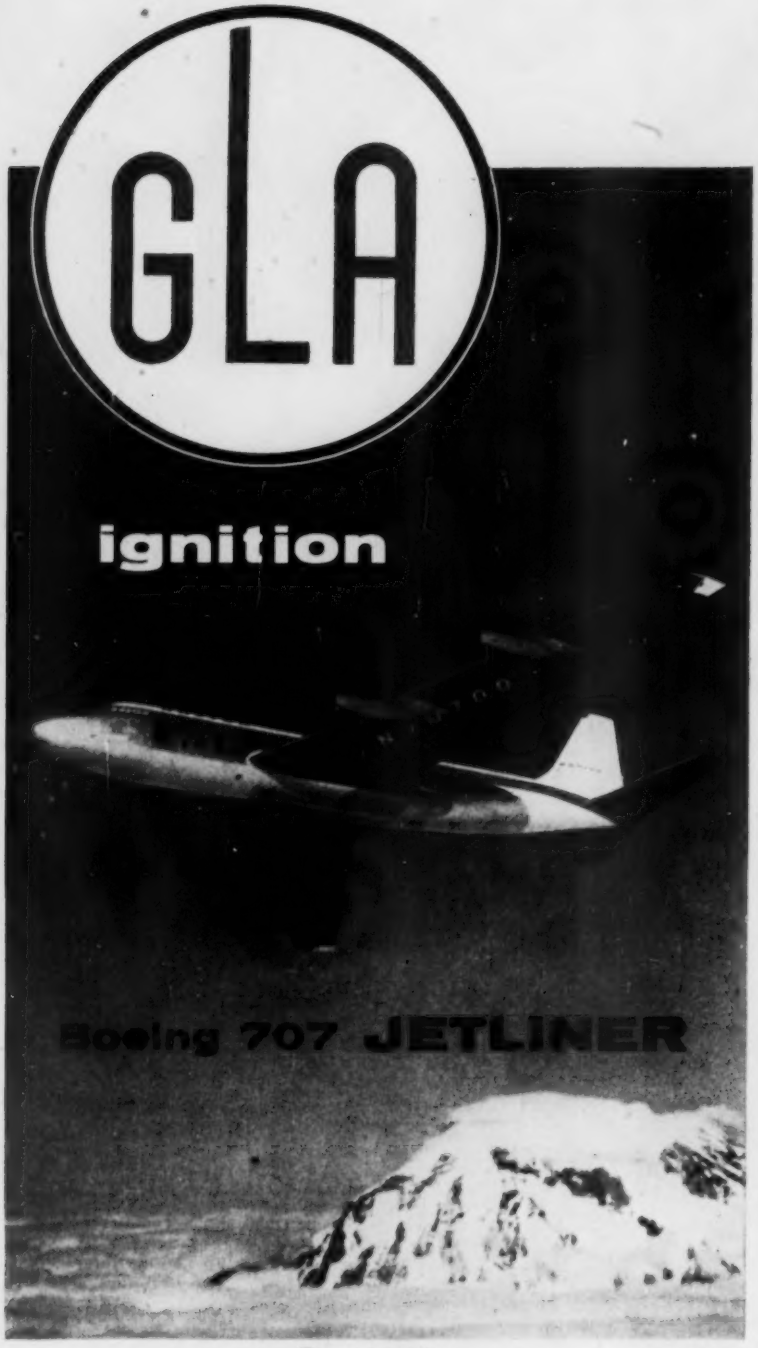

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AVIATION CALENDAR

(*Continued from page 5*)

Jan. 20-Feb. 7—Aviation Institute for Commercial Carriers and Business Pilots, Univ. of Southern California, Los Angeles.

Jan. 22-26—First International Air Show & Exposition, Master Field, Miami, Fla. For details write: P.O. Box 2879, Miami 17.

Jan. 27-30—26th Annual Meeting, Institute of the Aeronautical Sciences, Sheraton-Astor Hotel, N.Y.C. Honors Night Dinner, Jan. 29.

Jan. 29-31—Fourth Annual Meeting, American Astronautical Society, Main Auditorium, Engineering Societies Bldg., 29 W. 39 St., N. Y. C.

Jan. 30-31—American Society for Engineering Education, 1958 College-Industry Conference, U. of Michigan, Ann Arbor.

Jan. 30-31—Seventh Annual Instrument Short Course, sponsored by Southern California Meter Association and Los Angeles Harbor Junior College, at Los Angeles Harbor College, Wilmington, Calif.

Feb. 3-4—Industry-Service Symposium Flight Control-Panel Integration, Biltmore Hotel, Dayton, Ohio. For details: Mr. J. H. Kearns, Box 942, Dayton.

Feb. 19—"Are Flying Saucers Fact or Fancy?", Dr. Hugh Winn, Missile and Ordnance Systems Department, GE, Engineers Club, Philadelphia, Pa.

Mar. 13-14—Second National Conference on Aviation Education, Hotel Mayflower, Washington, D. C.

Mar. 17-20—Joint Aviation Conference, American Rocket Society-American Society of Mechanical Engineers, Statler-Hilton Hotel, Dallas, Tex.

Mar. 17-21—1958 Nuclear Congress, managed by American Institute of Chemical Engineers, 25 W. 45 St., N. Y. C.

Mar. 18-19—First Interscience and Industry Symposium on Guided Missiles Training equipment (limited to those with Secret clearance) Naval Ordnance Laboratory, White Oak, Silver Spring, Md. For details write: Mr. J. G. Vaeth, Head of New Weapons & Systems Division, U. S. Naval Training Device Center, Port Washington, L. I., N. Y.

Mar. 24-29—Fourth International Instrument Show, Caxton Hall, London.

Mar. 30-Apr. 1—RFC-RNAS Reunion (World War I), Toronto, Canada. Contact: C. B. Stenning, Chairman, 149 South Drive, Toronto 5.

Apr. 8-10—Eighth International Symposia, Electronic Wavegnides, Microwave Research Institute of Polytechnic Institute of Brooklyn Engineering Societies Bldg., 29 W. 39 St., N. Y. C.

Apr. 14-18—Annual Technical Meeting, American Welding Society, Hotel Statler, St. Louis, Mo.

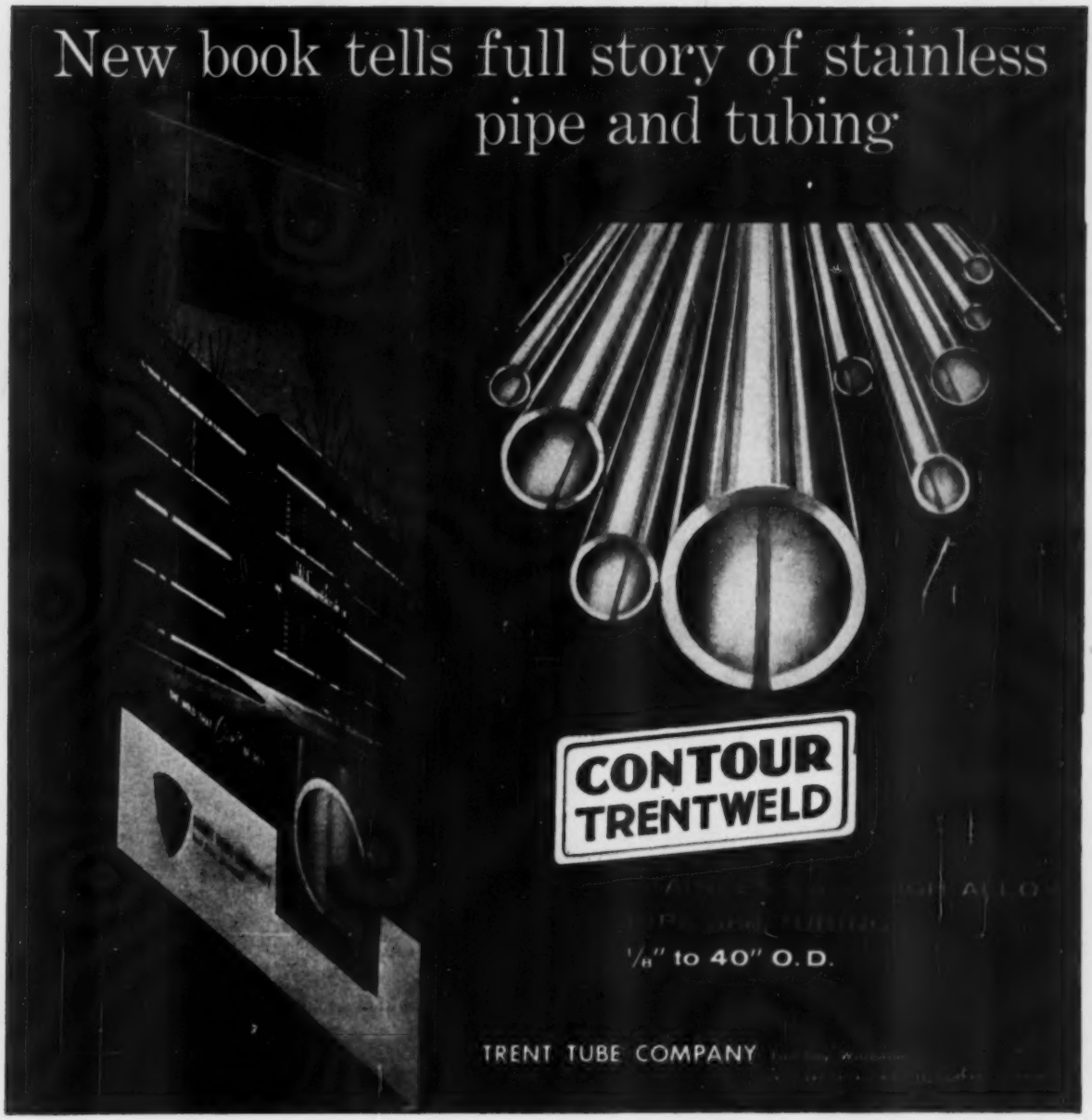
Apr. 16-19—14th Annual National Forum, American Helicopter Society, Sheraton-Park Hotel, Washington, D. C.

Apr. 17-18—Institute of Environmental Engineers, Second Annual Technical Meeting, New Yorker Hotel, New York.

Apr. 22-24—1958 Electronic Components Conference, Ambassador Hotel, Los Angeles, Calif.

Sept. 1-7—1958 Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, England.

New book tells full story of stainless pipe and tubing



If you use stainless or high alloy pipe or tubing, this new illustrated handbook was written for you. It's 48 pages big – packed with informative data that you'll refer to again and again.

The table of contents is too long to list here, but it includes, for example, analysis and conversion tables, corrosion characteristics, weights, alloy properties, bending, joining and installation hints.

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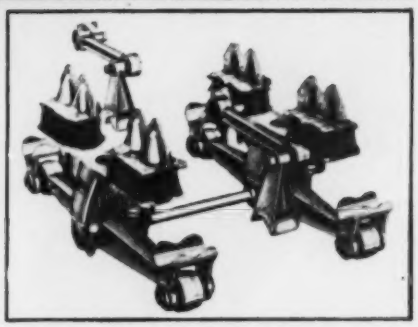

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COVER: Republic F-105 Thunderchief undergoes −65F cold weather tests at USAF climatic laboratory, Eglin AFB, Fla. Supersonic fighter-bomber will be flown to Alaska in January for flight and ground tests in cold weather environment. Area-ruled aircraft is 63 ft. 1 in. long, 19 ft. 8 in. high at tail, has 34 ft. 11 in. wingspan (AW Aug. 5, p. 30). Note fin ram air intake for afterburner cooling.

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EDITORIAL

Voodoo Brings Home the Bacon

Heartiest congratulations are due McDonnell Aircraft Corp., Pratt & Whitney Aircraft and Air Force Maj. Adrian Drew for bringing back the official world speed record to the U.S. with a 1,207.6 mph. average speed over the Edwards AFB official record course in the F-101A. This performance when homolgated by the Federation Aeronautique Internationale will bring the world speed record back to the U.S. from Great Britain where it has reposed since March, 1956, as a result of the 1,132 mph. performance of Peter Twiss in the Fairey FD.2 Delta research aircraft.

At the time the British recaptured the record from the North American F-100A, we wrote some lines—intended in no way to detract from the superb performance of the Fairey Delta and its pilot—criticizing the U.S. Defense Department policy of refusing to allow U.S. military aircraft to participate in world record breaking efforts.

Long-Time Capability

We noted then that there were already five USAF and Navy planes well along in flight testing that were capable of topping the 1,132 mph. British mark, and the F-101 Voodoo was one of those specifically mentioned.

At that time, some of our British friends were a bit skeptical of our claims, largely on the logical assumption that, if we had such planes, we would waste no time in nailing down the record. They, fortunately, were not acquainted with the ostrich head in the sand policies of the former Defense Secretary Charles E. Wilson or the even more ridiculous public relations policies of his then deputies in this department, Karl Honaman and Robert Tripp Ross.

Consequently, we are delighted to be able to offer concrete proof of our original thesis in the performance of Maj. Drew and the McDonnell F-101A. To get the proper time reference, it should be emphasized that the F-101A has been in service with operational units of the Tactical Air Command for more than a year and was quite capable of its currently recorded performance even longer ago.

Production Line Aircraft

The F-101A that set the record was a standard production line aircraft from an operational fighter-bomber wing of Tactical Air Command. It is armed with cannon and can carry a moderate sized atomic bomb. Although it would be naive to assume that some special "tuning up" was not done on this particular aircraft and its two Pratt & Whitney J57 turbojets for the record attempt, this speed mark was set with an aircraft that is essentially a fighting machine, not a racing craft.

It is also interesting to note the Soviet Union's attempt to get into the world speed record act with a hasty announcement that one of its fighters reached 1,242 mph. on a routine test flight by Lt. Col. Nicolai Korovushkin. The Soviets did not identify the plane by type but it could have been any one of several new Russian designs without straining our technical credulity. AVIATION WEEK reported as long ago as July, 1956, that the Soviet MiG-21 Faceplate (AW July 16, 1956, p. 33; Dec. 16, 1957, p. 67), which we observed in flight at Tushino, was in the 1,200 mph. speed class. Both the Fishpot delta series of Pavel Sukhoi and the rocket-powered interceptor in Red air force service are also capable of speeds in excess of 1,200 mph.

The interesting angle on the Soviet quick jump into print with Korovushin's unofficial performance was their sensitivity on the international prestige impact of superior technical performance. This was a point the former regime in our Defense Department could never grasp and, as a result, our prestige in this field took a severe and undeserved slump during their five-year tenure.

It is also interesting to note that the Soviets have been steadily filing official claims with the FAI for a wide variety of helicopter world record performances. We would not be surprised to see them make an officially recorded attempt to wrest the absolute speed record away from USAF and the F-101A.

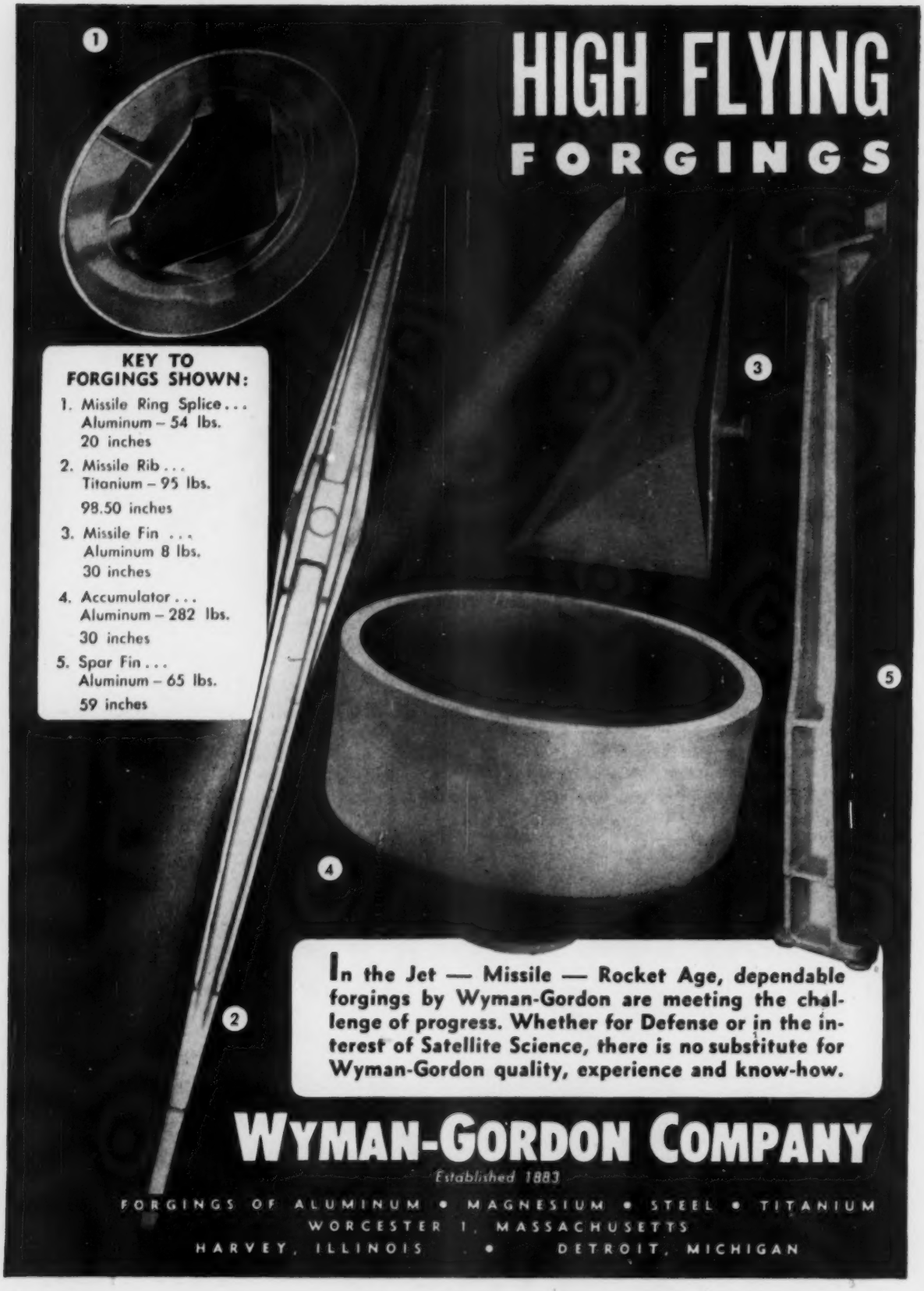
Recapture Altitude Record

There is one other item on the world record agenda that should be dealt with as soon as possible. That is the recapture of the altitude record held by Britain for many years and pushed last summer to 70,000 ft. by a Canberra bomber boosted by two Napier Scorpion rockets.

In this category it must be candidly admitted that, for a long time, we had no aircraft or engines capable of wresting this mark from the British. But we now have at least two fighters that can top the Canberra Scorpion mark. They are the Lockheed F-104A and the Grumman F11F-1F, both powered by the General Electric J79 turbojet. Both of these aircraft already have flown well in excess of 70,000 ft., and it would breach no genuine military security to permit them to do so for the official altitude record.

We are pleased to see both USAF and Navy taking a more active interest in the prestige of official records. The Navy's splendid performances with its carrier-based Vought F8U-1 Crusader have now been eclipsed by the USAF runs with the F-101A, and both our domestic confidence and international prestige have been bolstered by this spirited and technically sound rivalry. Lets keep it up.

—Robert Hotz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WHO'S WHERE

In the Front Office

Donald K. Tasker, a vice president, Marquardt Aircraft Co., Van Nuys, Calif.

Stanley Gewirtz, vice president and assistant to the president, Air Transport Association of America, Washington, D. C.

James C. Cupp, vice president and chief engineer, and **Arthur B. Mayer,** sales manager, Condenser Research Corp., subsidiary of Marathon Electric Manufacturing Corp., Seymour, Ind.

Zeke R. Smith, vice president and director of engineering, Potter & Brumfield, Inc., subsidiary of American Machine & Foundry Co., Princeton, Inc.

Capt. Jack E. Gallagher, vice president operations, New York Airways, Inc., New York, N. Y.

Tad Stanwick, a corporate vice president, Cleveland Pneumatic Tool Co., Cleveland, Ohio.

Dr. Robert M. Page, director of Research, Naval Research Laboratory, Washington, D. C.

Col. James W. Anderson, Jr. (USAF, ret.), special assistant to the board chairman, The Magnavox Co., Fort Wayne, Ind.

Louis W. Davis succeeds **William G. Key** as assistant to the president, Fairchild Engine and Airplane Corp., Hagerstown, Md.

Dr. Walter R. Dornberger, technical assistant to the president, Bell Aircraft Corp., Buffalo, N. Y.

Robert J. Norris, administrative assistant to the vice president of engineering and maintenance, Pacific Northern Airlines, Inc.

Honors and Elections

Roy T. Hurley, chairman and president of Curtiss-Wright Corp., has been elected to New York University's Board of Trustees.

Francis L. Hine, president of Airwork Corp., has been elected president of the Aviation Distributors and Manufacturers Association, Philadelphia, Pa., and **D. H. Hollowell,** of Continental Motors' Aircraft Division, and **Paul A. Kennedy,** of Southwest Airmotive, have been elected vice presidents.

Changes

Gene Hopkins, manager-Dayton, Ohio, corporate office, The Martin Co., Baltimore, Md.

T. R. Just, administrative engineer-testing division, Engineering Dept., Douglas Aircraft Company, Inc., Santa Monica, Calif.

George E. Ellis, industrial products manager, Stratos Division, Fairchild Engine and Airplane Corp., Bay Shore, N. Y.

Robert D. Davis, manager-marketing department, Research and Advanced Development Division, Avco Manufacturing Corp., Lawrence, Mass.

Thomas S. Mederos, sales assistant to the president, Applied Science Corporation of Princeton, Princeton, N. J.

Richard L. Snyder, manager semiconductor plant, Sylvania Electric Products, Inc., Woburn, Mass.

INDUSTRY OBSERVER

► Bell BOMI hypersonic glider project (AW Dec. 2, p. 28) would utilize double wall construction to solve problem of aerodynamic heating. Three-quarter inch space between inner and outer walls would be filled with lithium which would be used both as a coolant and as a fuel. Bell has made 652 presentations to the military on this project without obtaining a decision. North American Aviation also is incorporating double wall construction into its X-15 high-altitude research aircraft.

► Lockheed Missile Systems Division is testing approximately 15 different shapes in its Polaris fleet ballistic missile program. The various shapes are now being evaluated as scale models, probably in very high speed wind tunnels. Nose cone tests are being conducted with scale models in shock tubes.

► Airlines, after considerable debate over whether to use JP-4 or kerosene in their jet aircraft, have decided on the latter. Carriers will use ASTM Type A which has a freezing point of −58F. Decision probably will be formally ratified by the technical committee of the International Air Transport Assn. Petroleum company sources say a round figure for the cost of the kerosene in quantity would be 15 cents per gal. This compared to the round figure cost of 18 cents per gal. for 100/130 octane gasoline used in most of today's piston-engine airliners. There also is a tax on gasoline which does not apply to kerosene.

► Inertial guidance system for Air Force Thor intermediate range ballistic missile reportedly can accommodate engine thrust variations several times greater than that of the inertial guidance system used in Army's Jupiter IRBM.

► Sikorsky is cutting metal for a new, company-financed helicopter designated the S-62. Helicopter will have a flying boat hull on the order of the S-61 (AW Oct. 7, p. 23) but will approximate the S-55 in weight class.

► Two oxidizers are receiving increased attention from rocket propellant research groups. Jet Propulsion Laboratory of California Institute of Technology has purchased 75,000 lb. of nitrogen textroxide, a very dense liquid which was previously used in 100 lb. lots. Army Chemical Corps has ordered 400,000 lb. of chlorine trifluoride, which is a more efficient oxidizer than those now in use and much easier to handle than fluorine.

► Advance design characteristics of Northrop's T-38 supersonic trainer have been successfully flight tested through use of variable stability aircraft at National Advisory Committee for Aeronautics' Ames Aeronautical Laboratory, Moffet Field, Calif. Variable stability aircraft used for the tests was a North-American F-100.

► Sundstrand Aviation Division of Sundstrand Machine Tool Co., Rockford, Ill., has acquired American Machine & Foundry Co.'s Turbo Division in Pacoima, Calif. Turbo Division, one of 16 prime contractors in the ballistic missile program, is building auxiliary power supplies for both ICBM and IRBM projects. Before sale was made to Sundstrand, seven bidders—including Thompson Products Inc.—were involved in negotiations with American Machine & Foundry for purchase of the division.

► Convair B-58 Hustler supersonic bomber suffered landing gear damage recently when brakes malfunctioned on landing at Kirtland AFB, N. M. Aircraft, with pod attached, had taken off on test flight, but failure of telemetry forced the aircraft to return to its base. Touching down at a high gross weight, Convair test pilot W. Winchell rode aircraft down 90% of the runway before running it off the side to avoid more severe damage that would have been incurred by going off the end of the runway. Crew was shaken up but unhurt. Pod, which has a base value starting at $250,000, was undamaged.

► Douglas' El Segundo Division is developing an airborne missile that will be controllable in flight by pilot of the mother aircraft.

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Washington Roundup

U. S. Atomic Secrecy

Congress is ready to open the door for disclosure of technical atomic information to NATO nations as a top order of business when sessions begin next month. The 1946 Atomic Energy Act, written in the period of a U.S. atomic monopoly, bans any disclosure.

There appears to be general agreement on a basic first step—remove the legislative ban and make the disclosure of technical atomic information a matter of executive discretion, along with all other types of defense information.

But there are still congressional apprehensions. Controversy over what strings should be attached to this general proposal is expected.

New York's Rep. Kenneth B. Keating, ranking Republican member of the House Judiciary Committee, wants a standardization of security safeguards among the NATO nations as a pre-condition to free interchange of atomic information in the interest of mutual scientific advancement.

A study prepared for the Joint Committee on Atomic Energy by Thomas E. Murray, a former member of the Atomic Energy Commission and now a consultant to the congressional committee, recommends a two-step approach. It says: "In the first phase, the exchange should be limited to technical data on small weapons. The value of withholding this information from friendly nations has diminished to the point where it ought to give way to higher considerations of unity in the common defense. However, there should be a postponement—of three to five years—of the second phase of exchange, which would be concerned with large weapons. The value of secrecy with regard to the science and technology of large weapons still remains paramount, at least for the time being."

Nixon: 'Can Spend'

There is new evidence that Vice President Richard M. Nixon is grabbing the bull by the horns to lead a public education program on the necessity for an all-out U.S. effort in missile and space technology (AW Dec. 16, p. 25).

Nixon made a surprise appearance last week at an Air Force Assn. seminar conducted as a public service to educate newspaper reporters, magazine writers and radio-television men on the mysteries of the missile era. Contrary to the doctrines laid down not many months ago by Republican spokesmen, Nixon said the U.S. "can spend all we need to spend" for national defense. He appealed for full maintenance of the Strategic Air Command until the missiles are ready, refused to fix political blame for U.S. tardiness in the ballistic field.

Nixon created an excellent impression on the press, showed signs of sound preparation for his short speech, which was delivered without notes or text. Most important of all, he exhibited understanding of the military, technical and public relations problems involved in getting the U.S. on the road to progress.

Astronautics Cost

Contrary to the general opinion, Richard Horner, Assistant Secretary of the Air Force for Research and Development, does not believe entry into astronautics involves budget-breaking finances. Horner told the Senate Preparedness Subcommittee that the work can be done inexpensively.

A small investment, he said, can turn USAF's existing industrial plants, technology and test facilities to the problems of conquering space.

Soviet Trims Bureaucracy

It hasn't been widely publicized, but Moscow has shaken up its ministry organization to facilitate preparations for war. Four ministries concerned with defense production have been abolished and replaced by a State Committee on Defense Technique, headed by A. V. Domrachev, with a rank higher than that of a minister. This is a promotion for Domrachev, who was Minister of Defense Industries.

Possibly even more important is the fact that the Aviation Industry Ministry was wiped out, replaced by a "State Committee" that operates on a higher level. It is headed by Peter Dementyev, former minister of the aviation industry.

Western observers assume the various changes are designed to clear red tape delays, speed weapons to the using commands.

Bilateral Fears

Airlines are becoming alarmed for the third time this year over the manner in which the State Department is negotiating air transport agreements with foreign countries. Current situation results from talks now being conducted with France.

A representative of one U.S. international carrier said U.S. airlines have not yet been informed of just what France is seeking, although the French have indicated publicly that they want a route to the U.S. West Coast and a Polar route to the Orient. The spokesman said the State Department, after standing pat against the awarding of new routes to France earlier, may be willing to "give in" on a West Coast route. The Civil Aeronautics Board is willing to go along with State on that—another puzzle to the airlines.

Another spokesman said last week's apparent willingness to give France at least one additional route could have been "window dressing" for the NATO conference in Paris.

CAB: Space Denial

Civil Aeronautics Board is at least one government agency that hasn't yet bought the idea of space flight. In denying the first recorded formal application for interplanetary space routes, the Board ruled the request premature "since at the present time no commercial equipment is available and there is no indication as to the present feasibility of such service or traffic which might move to points beyond the earth."

The formal application for authority to operate a space carrier between the U.S. and points in the universe was filed recently by Terminal Transports Co. Inc., of Atlanta. The Board chose to follow the examiner's recommendation that pointed out that the applicant failed to designate routes and terminal or intermediate points on the proposed routes. The examiner also emphasized his recommendation was based in part upon the applicant's failure to document the type of space machine he proposed to use. —Washington staff

Pentagon Girds for New Research Feud

Military services are ready to battle for control of R&D with less Defense Department interference.

By Claude Witze

Washington—New battle over the direction of research talent and funds is under way in the Pentagon with the military services ready to fight for control with less interference from Defense Department monitors.

Military research and development spokesmen in the armed forces already are starting to receive support from some important defense contractors.

The fight may assume proportions that surpass in bitterness and importance the clashes of last spring when the Defense Science Board rebelled against the conservative dictatorship of Frank D. Newbury, the Assistant Secretary of Defense for Research and Engineering (AW April 15, p. 26).

Genesis of the new conflict was an announcement by Defense Secretary Neil H. McElroy that he will establish a new Advanced Research Projects Agency—a single manager to control the anti-missile missile, space flight and other "upstream" projects. This agency, McElroy indicated, will carry on research and development, turning over the new weapons to using commands when they are close to operational capability (AW Nov. 25, p. 26).

Attack by Kimball

Most spirited attack on the McElroy concept was made here last week by Dan A. Kimball, former Secretary of the Navy and now president of Aerojet-General Corp., manufacturer of rocket engines for guided missiles.

"These programs," Kimball told an American Rocket Society meeting, "are clearly military and the problem of making them operational belongs to the services, not to an Advanced Research Agency. . . .

"Any research agency which would try to supervise all these phases of missile development would only introduce excessive costs, unnecessary delays and inferior end products from the operational point of view.

"What we need is not so much another high level organization as a new kind of organization at high level—an organization which will simplify, not duplicate, the task of reaching an effective solution to our missile problems.

"We need a system which will supervise but not interfere."

Kimball made it clear he was talking about advanced research, beyond the satellite and anti-missile programs.

At the working level, where the impact of McElroy's decision was slow to be recognized, USAF was the first of the armed services to run afoul of the Defense Department program.

Holaday Raps USAF

Accused of an attempt to "grab the spotlight" in the newly-respectable field of space flight, the Air Force has temporarily withdrawn its order setting up a Directorate of Astronautics in the office of the Deputy Chief of Staff for Development (AW Dec. 16, p. 26).

Charge that the action "jumped the gun" was made by the Defense Department's Director of Guided Missiles, William M. Holaday, before the Senate Preparedness Subcommittee. Acknowledging that the astronautics field is outside his jurisdiction, Holaday said he still opposes the consolidation of USAF's activity at this time.

Reason given was that the new Advanced Research Projects Agency has not been established nor a director chosen to head it. In the absence of Defense Secretary Neil H. McElroy, in Europe for the NATO conference, Holaday took his case to Deputy Defense Secretary Donald A. Quarles and won immediate support. Quarles said he asked USAF not to establish the new directorate.

In withdrawing the order signed by Lt. Gen. Donald L. Putt, USAF deputy chief of staff, development, USAF called it "premature." Secretary James H. Douglas declared the action was the result of a misunderstanding and contrary to a promise he had made that nothing would be done until it could be coordinated with the plans for ARPA.

The Air Force Secretary said the purpose of the new directorate will be to serve as a contact with ARPA, but it was not made clear why USAF's consolidation of "upstream" projects must await formation of the new and apparently unpopular defense agency.

USAF Opposition

Almost immediately after the Air Force retreat, witnesses from Air Force headquarters made it clear to the Senate Preparedness Subcommittee that they look with disfavor on Advanced Research Projects Agency.

Even Douglas, asked why all three services need separate research and development programs, pulled no punches in his reply:

"You only get urgent effort from the user and prospective user. You never get effective pursuit except when you have the user expressing the need" and doing the work.

Douglas said he had no objection to having basic research done elsewhere, "but once you move over the poorly defined line to applied research, I would object."

The Secretary was supported vehemently by his military colleagues.

Said Lt. Gen. Clarence S. Irvine, deputy chief of staff, materiel:

"What we don't need in Washington are more committees, czars, directors, secretaries—we need more decisions from the Secretary of Defense.

Gen. Irvine said the Secretary should hand out roles and missions and, if they are not carried out, "crack heads."

Gen. Putt, who raised the storm over USAF's new Directorate of Astronautics, was asked by the senators if

Double Management Perils

"The satellite and space weapons programs which are just ahead will require hardware, facilities and trained people. The nucleus of these now exists in such programs as the Air Force ballistic missile program, where the effort has been to develop hardware, production facilities and to train personnel for operational duties in parallel.

"Double management—by the services and by the Department of Defense—results in confusion and inefficiency. There is always present potential or actual interference—always at higher cost to the government and loss of quality in the end product.

"The Department of Defense was originally visualized by Secretary Forrestal, who was one of the principal advocates of unification, as a small organization of perhaps 100 persons who would set policy for the Military Departments.

"It has grown into a super-group of more than 5,000 persons who have taken on the job of reviewing and amending whatever the services are doing or propose to do.

"By this growth and change of direction—by knocking heads together, as they used to say—and more recently by starting and stopping programs with every latest reading of the wind of Russian propaganda, we have lost track of the goal of effectiveness and we are devoting ourselves more and more to trying to solve crises week by week.

"To be specific—I think we should set up an organization to meet our needs today, tomorrow and for a long time to come."—Dan A. Kimball, president, Aerojet-General Corp.

he thought a civilian agency should be established to bring new weapon systems into operation. He said "I do not," and continued:

"As weapons become more complex it is absolutely necessary that the user develop the operational concept, ground handling support, training, preparation of bases, etc."

The general said he feared a civilian agency to develop prototypes and then show the armed forces what they will do "would stretch out the time instead of shortening it."

Negative by Schriever

The same point was emphasized by Maj. Gen. Bernard A. Schriever, commander of USAF's Ballistic Missile Division. He said:

"If you ever separate research and development of military weapons from the user, you are going to stretch the time of development."

Gen. Schriever said he wanted to register with the Senate group "a strong negative against ARPA. This would be a very great mistake."

In the month that has elapsed since McElroy announced his intention of creating the new single manager agency, there has been almost nothing to clarify his plan or give more details. In his testimony, Holaday indicated that the ARPA office will control funds only and that the armed services will continue to work on their own research and development programs.

This is contrary to the impression given by McElroy a month ago. At that time, he said the single manager will assemble a "fairly substantial sized research and development effort" with "those people who have been working in these areas in the past as the nucleus."

Need for Decision

On this subject, Kimball, a veteran of many years' experience in the Pentagon, voiced a firm opinion in his speech to the Rocket Society.

The Aerojet president said "we don't need any more overlapping agencies.

"We need decisions—decisions that stick—in the Defense Department.

"We need to have these decisions implemented by the military services, not by a hodge podge of Department of Defense people trying to adjust the military programs."

Then Kimball spoke about a top-level research and development staff.

"Research and development project management requires a rather large and competent technical and procurement staff.

"Such a staff does not exist in the Department of Defense and obtaining such a staff would be difficult and time consuming.

"A research and development organization has no place in the Department of Defense, where it duplicates the separate efforts of the armed services."

Kimball said he wanted to propose a program to "put America on the road to missile supremacy" and replace "the haphazard system we've been using."

He said the appointment of Dr. James R. Killian, president of the Massachusetts Institute of Technology, as a special assistant to President Eisenhower was a good starting point but "we need more than advice to the President." Kimball suggested:

- **Dr. Killian and his scientific** advisers should set missile policy for a Director of Guided Missiles.
- **Director of Guided Missiles** should be appointed by the President, confirmed by the Senate for a specific period of years. He should work for the Secretary of Defense.
- **Only a small staff is needed** by the Director of Guided Missiles to direct the work of the armed services, but not do it for them. The director must not be at the mercy of civil advisers whose opinions can outweigh those of the military men.

The rocket manufacturer said insufficient money is being spent on advancing the state of the art.

Stepping into the current problem of the Thor and Jupiter intermediate range ballistic missile production order, Kimball indicated that he does not believe the Army should be allowed to produce Jupiter for USAF use.

He said the Director of Missiles should have authority to determine types and missions and allocate development and production to the service which will be responsible for operation.

For Congress, he urged a simplification of legislation concerning construction of facilities and procurement methods—to make it easier for industry and government to get together.

Congress to Boost Defense Budget Above Administration Requests

By Evert Clark

Washington—Substantial increase in the Fiscal 1959 military budget—even beyond what the Administration will ask—appears certain as a result of the Senate Preparedness Investigating Subcommittee's extensive look at missile and satellite programs.

Increases are expected to range far outside the missile area to cover aircraft, submarines, warning and detection systems, research, operating funds and personnel.

Major points developed thus far in questioning of military and scientific leaders are:

- **Fiscal 1959 budgets** have been prepared largely on the basis of fiscal guidelines laid down before Defense Secretary Charles E. Wilson left office, rather than on needs, and reflect little awareness of the Russian threat as evidenced by missile and satellite launchings.
- **Major deficiencies exist** almost across the board in military programs, especially in USAF's Strategic Air Command and Navy's missile submarine and anti-submarine programs. Supplemental requests for Fiscal 1958 funds and the planned 1959 budget still do not correct this.
- **Subcommittee does not believe** the Administration has yet caught the proper "sense of urgency" even though military witnesses were outspoken about harmful effects of fiscal ceilings over the past several years.
- **Atlas intercontinental ballistic** missile program was accelerated as of last week, but a strong Air Force recommendation for acceleration of Titan ICBM program had not yet been approved by Defense Department when Air Force witnesses testified.

Subcommittee Chairman Lyndon Johnson (D. Tex.) also is Senate majority leader and a member of the Appropriations and Armed Services Committees. He has continually pressed military witnesses for specific answers on their needs and has assured them he will do everything possible to see that the needs are filled.

Republican minority members of the

GEN. CURTIS E. LeMAY

GARRISON NORTON

subcommittee have made few attempts to defend the Administration's budgetary limitations on military programs.

Testimony on the seriousness of the current situation has ranged from mild concern to the statements of Gen. Curtis LeMay, USAF vice chief of staff, that the U. S. probably is ahead of Russia in air striking power right now but probably will not be before war comes.

LeMay Doubtful

"I think we have waited pretty long," Gen. LeMay said. "It is doubtful in my mind whether we can catch up before we have a general war, but I sure want to try.

"Unless we do something and something very radical we will be in an inferior military position with Russia in a very short time. What worries me is while we are enjoying a superior position we are not doing very well . . . in an inferior position, we are going to lose ground very rapidly."

Subcommittee asked some 100 industry and science leaders by letter what bottlenecks they had found in the defense system and what they recommend to remove them.

In addition to a number of recommendations that military research and development—particularly for space flight—be put under a new civilian agency, many of the letters called for a stronger sense of urgency within the Defense Department and the Administration, considerable streamlining of the defense management organization, more freedom for contractors in making technical decisions and long-range funding of research and development instead of year-to-year funding.

Some letters called for a crash program on space flight.

Industry leaders will testify when hearings resume Jan. 7. Educators also have been asked to submit recommendations for improving scientific and technological training.

Members Dissatisfied

Subcommittee members expressed dissatisfaction with testimony of Defense Department Director of Guided Missiles William Holaday as to what authority he now has and what he is doing to accelerate missile development and production, but they denied reports, printed several days after he testified, saying most of them thought he should resign.

Holaday revealed plans to launch a satellite at least as heavy as Sputnik II's 1,120 lb. but would not give the timetable in open session.

Acceleration of the Atlas, he said, will require more money for Fiscal 1958

JAMES H. DOUGLAS

and "about one third more than was planned" for Atlas in Fiscal 1959.

Maj. Gen. John B. Medaris, chief of the Army Ballistic Missile Agency, said a committee he served on urged development of a 220,000 lb. thrust rocket engine in the summer of 1956 because "we felt we couldn't get away with any more" thrust than that. An engine of "much higher thrust" is "coasting along on an engineering basis" at North American Aviation Inc. now because "nobody can put down their finger today on the specific project for which they need the engine." He urged development of it on "a crash basis."

Dr. Wernher von Braun, technical director of the Army missile program, urged creation of a National Space Agency with a $1.5 billion budget and a goal of putting man into space and retrieving him within the next five years and establishing a manned space system in 10 years.

He also criticized interference from committees and said he had to visit the Pentagon twice a month and Medaris once a week to justify programs and to talk with committees.

Lt. Gen. James M. Gavin, Army chief of research and development, urged replacement of the Joint Chiefs of Staff with an "integrated" staff system using three and four-star general officers who would then retire or serve in unified theater commands.

Garrison Norton, Navy Undersecretary for Air, was the most outspoken critic of the "total dollar straitjacket" imposed on the services for the past few years and said it had seriously hampered research, procurement and combat readiness. He said the Secretary of Defense told the Navy to cut its budget, and he assumed the President told the Secretary of Defense what to do. Norton also is responsible for Navy research and development.

Polaris Breakthrough

Other Navy witnesses praised the Polaris 1,500 mi. fleet ballistic missile program highly and said there have been "most significant technological breakthroughs in all areas," including navigation, solid propellants and guidance.

Except for Polaris, which has been greatly accelerated since the Oct. 4 firing of the Soviets' first earth satellite, there has been only slight relief from budget ceilings in research and in aircraft procurement, they said.

Adm. Arleigh Burke, Chief of Naval Operations, called for "more money, men and ships"—especially submarines and anti-submarine equipment. Navy called the Russian submarine-missile threat without parallel in history.

Air Force officials called for more effort in every area, from crews, operational funds, aircraft and dispersal for Strategic Air Command to research on spacecraft, anti-satellite missiles and defensive satellites.

Gen. LeMay said "a majority of SAC

DR. WERNHER VON BRAUN

was grounded for the last five weeks" of Fiscal 1957 for lack of gasoline. Others put more emphasis upon near and far future weapons but most USAF witnesses agreed aircraft, missiles and space problems should share about equal priority.

Gen. LeMay and Lt. Gen. Donald L. Putt, USAF Deputy Chief of Staff for Development, testified the U. S. probably would not detect more than one or two ICBMs if Russia fired them at this country now and said even that would be "accidental."

Putt spoke of "recent" breakthrough in ICBM detection work and said work should proceed as fast as possible on a warning system. He recommended public education on military research problems, streamlining of decision making machinery, and consistent research effort, and said he would have asked for another $150 to $250 million for his work if the Fiscal 1959 budget had not had a ceiling.

Maj. Gen. Bernard A. Schriever, commander of USAF's Ballistic Missile Division, said Thor, Jupiter, Atlas or Titan would make perfect boosters to place considerable weights in orbit, or even to fire a rocket to the vicinity of the Moon by 1959.

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Cornell Will Direct Reconnaissance Study

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The $1.5 million contract will secure the services of 35 Cornell scientists. Their function will be to:

- **Evaluate present combat** reconnaissance programs within the Department of Defense.
- **Review** tactics of present and planned reconnaissance procedures.
- **Devise and recommend** new reconnaissance systems and supporting research programs.

Presently stated objectives of the study are to provide battlefield commanders with continuous means to scan a large area, locate targets, prepare missile guidance information, fire a missile, and observe the results almost instantaneously. Surveillance packages would be designed to fit into drones and to be carried by high performance manned reconnaissance aircraft such as the Grumman AO-1.

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- William Holaday, Director of Guided Missiles—"I was playing it safe to give us early availability of a number of missiles." After Holaday made his recommendation, Defense Secretary Neil McElroy briefed President Eisenhower on the plan. Final decision was made Nov. 27 at the White House in a meeting attended by Vice President Richard Nixon, Presidential Assistants Sherman Adams and James R. Killian, Jr., Budget Bureau Director Percival Brundage, Secretary of State John Foster Dulles, McElroy, Deputy Defense Secretary Donald A. Quarles and Holaday.

This prompted subcommittee counsel Edwin Weisl to ask: "Of all these men, how many know anything about missiles?"

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USAF Reports

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Only a few hours before the Atlas shoot, J. R. Dempsey, director of the program for Convair, said he was expecting a call from the Defense De-

services, not to an Advanced Research Agency.

"Any research agency which would try to supervise all these phases of missile development would only introduce excessive costs, unnecessary delays and inferior end products from the operational point of view.

"What we need is not so much another high level organization as a new kind of organization at high level—an organization which will simplify, not duplicate, the task of reaching an effective solution to our missile problems.

"We need a system which will supervise but not interfere."

Kimball made it clear he was talking about advanced research, beyond the satellite and anti-missile programs.

At the working level, where the in-

"It has grown into a super-group of more than 5,000 persons who have taken on the job of reviewing and amending whatever the services are doing or propose to do.

"By this growth and change of direction—by knocking heads together, as they used to say—and more recently by starting and stopping programs with every latest reading of the wind of Russian propaganda, we have lost track of the goal of effectiveness . . . we are devoting ourselves more and more to trying to solve crises week by week.

"To be specific—I think we should set up an organization to meet our needs today, tomorrow and for a long time to come."—Dan A. Kimball, president, Aerojet-General Corp.

doing the work.

Douglas said he had no objection to having basic research done elsewhere, "but once you move over the poorly defined line to applied research, I would object."

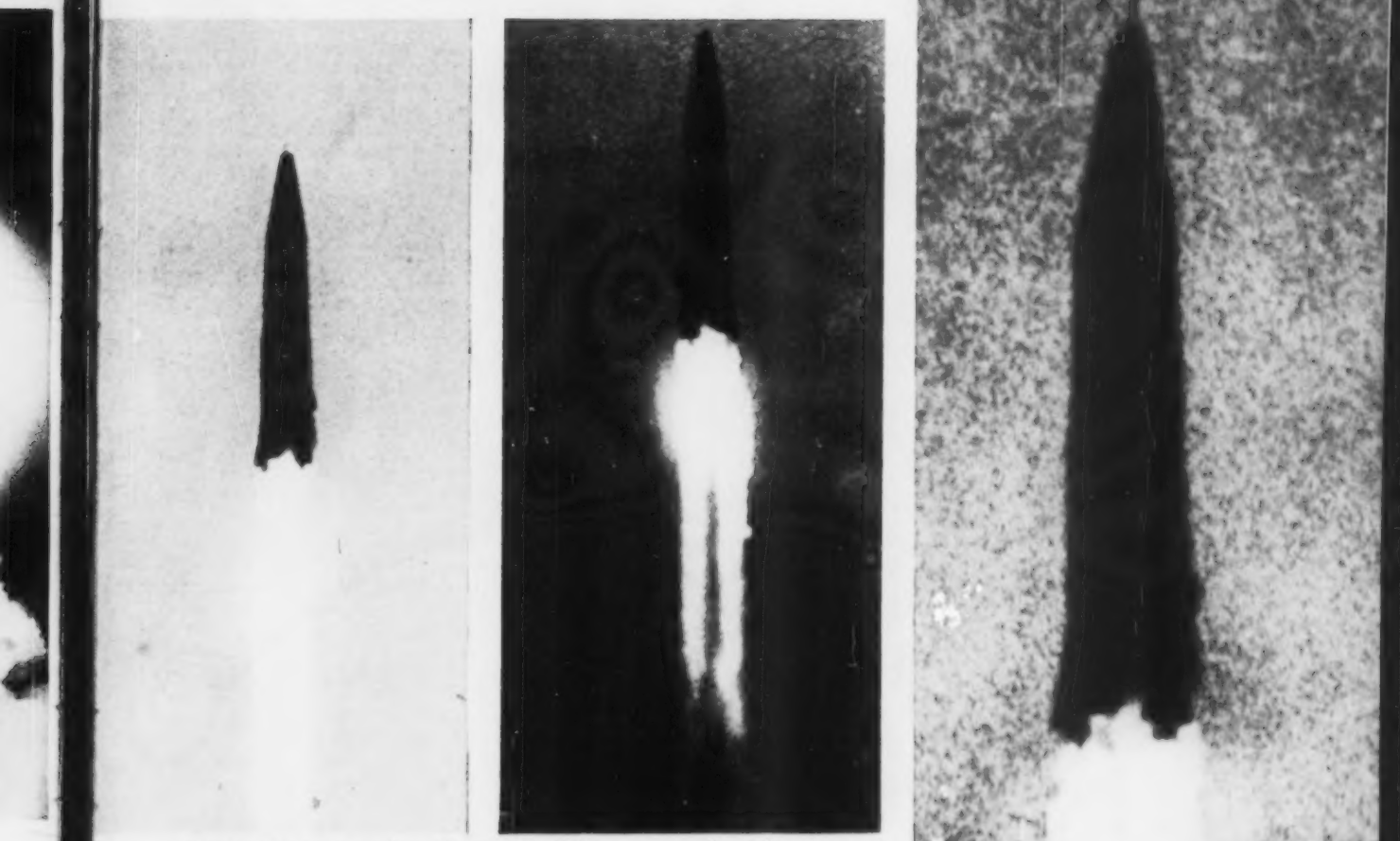
The Secretary was supported vehemently by his military colleagues.

Said Lt. Gen. Clarence S. Irvine, deputy chief of staff, materiel:

". . . we are more committees, cracks, directors, secretaries—we need more decisions from the Secretary of Defense."

Gen. Irvine said the Secretary should hand out roles and missions and, if they are not carried out, "crack heads."

Gen. Putt, who raised the storm over USAF's new Directorate of Astronautics, was asked by the senators if



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Maj. Gen. Bernard A. Schriever, commander of USAF's Ballistic Missile Division, told the Senate Preparedness Investigating Subcommittee the day of the firing that he is completely confident the Atlas nose cone problem has

package, visible in some of the photos. Length of the nose section, including corrugations, is 7.4 ft.

Action Log

Washington—Here's the action announced by the U. S. last week in its battle to challenge the Soviet Union's technological propaganda lead:

• Successful launching of Atlas inter-

The Aerojet president said "we must need any more overlapping agencies.

"We need decisions; decisions that stick—in the Defense Department.

"We need to have these decisions implemented by the military services, not by a hodge podge of Department of Defense people trying to adjust the military programs."

Then Kimball spoke about a top-level research and development com-

"Research and development project management requires a rather large and competent technical and procurement staff.

"Such a staff does not exist in the Department of Defense and obtaining such a staff would be difficult and time consuming.

"A research and development organi-

than on needs and reflect little awareness of the Russian threat as evidenced by missile and satellite launchings.

• Major deficiencies exist almost across the board in military programs, especially in USAF's Strategic Air Command and Navy's missile submarine and anti-submarine programs. Supplemental requests for Fiscal 1958 funds and the planned 1959 budget still do not correct this.

• Subcommittee does not believe the Administration has yet caught the proper "sense of urgency," even though military witnesses were outspoken about harmful effects of fiscal ceilings over the past several years.

• Atlas intercontinental ballistic missile program was accelerated as of last week, but a strong Air Force recom-

GEN. CURTIS E. LeMAY

GARRISON NORTON

subcommittee have made few attempts to defend the Administration's budgetary limitations on military programs.

Testimony on the seriousness of the current situation has ranged from mild concern to the statements of Gen. Curtis LeMay, USAF vice chief of staff, that the U. S. probably is ahead of Russia in air striking power right now but probably will not be before war comes.

LeMay Doubtful

"I think we have waited pretty long," Gen. LeMay said. "It is doubtful in my mind whether we can catch up before we have a general war, but I sure want to try.

"Unless we do something and something very radical we will be in an inferior military position with Russia in a very short time. What worries me is while we are enjoying a superior position we are not doing very well . . . in an inferior position, we are going to lose ground very rapidly."

Subcommittee asked some 100 industry and science leaders by letter what bottlenecks they had found in the defense system and what they recommend to remove them.

In addition to a number of recommendations that military research and development—particularly for space flight—be put under a new civilian agency, many of the letters called for a stronger sense of urgency within the Defense Department and the Administration, considerable streamlining of the defense management organization, more freedom for contractors in making technical decisions and long-range funding of research and development instead of year-to-year funding.

Some letters called for a crash program on space flight.

Industry leaders will testify when hearings resume Jan. 7. Educators also have been asked to submit recommendations for improving scientific and technological training.

Members Dissatisfied

Subcommittee members expressed dissatisfaction with testimony of Defense Department Director of Guided Missiles William Holaday as to what authority he now has and what he is doing to accelerate missile development and production, but they denied reports, printed several days after he testified, saying most of them thought he should resign.

Holaday revealed plans to launch a satellite at least as heavy as Sputnik II's 1,120 lb. but would not give the timetable in open session.

Acceleration of the Atlas, he said, will require more money for Fiscal 1958

JAMES H. DOUGLAS

and "about one third more than was planned" for Atlas in Fiscal 1959.

Maj. Gen. John B. Medaris, chief of the Army Ballistic Missile Agency, said a committee he served on urged development of a 220,000 lb. thrust rocket engine in the summer of 1956 because "we felt we couldn't get away with any more" thrust than that. An engine of "much higher thrust" is "coasting along on an engineering basis" at North American Aviation Inc. now because "nobody can put down their finger today on the specific project for which they need the engine." He urged development of it on "a crash basis."

Dr. Wernher von Braun, technical director of the Army missile program, urged creation of a National Space Agency with a $1.5 billion budget and a goal of putting man into space and retrieving him within the next five years and establishing a manned space system in 10 years.

He also criticized interference from committees and said he had to visit the Pentagon twice a month and Medaris once a week to justify programs and to talk with committees.

Lt. Gen. James M. Gavin, Army chief of research and development, urged replacement of the Joint Chiefs of Staff with an "integrated" staff system using three and four-star general officers who would then retire or serve in unified theater commands.

Garrison Norton, Navy Undersecretary for Air, was the most outspoken critic of the "total dollar straitjacket" imposed on the services for the past few years and said it had seriously hampered research, procurement and combat readiness. He said the Secretary of Defense told the Navy to cut its budget, and he assumed the President told the Secretary of Defense what to do. Norton also is responsible for Navy research and development.

Polaris Breakthrough

Other Navy witnesses praised the Polaris 1,500 mi. fleet ballistic missile program highly and said there have been "most significant technological breakthroughs in all areas," including navigation, solid propellants and guidance.

Except for Polaris, which has been greatly accelerated since the Oct. 4 firing of the Soviets' first earth satellite, there has been only slight relief from budget ceilings in research and in aircraft procurement, they said.

Adm. Arleigh Burke, Chief of Naval Operations, called for "more money, men and ships"—especially submarines and anti-submarine equipment. Navy called the Russian submarine-missile threat without parallel in history.

Air Force officials called for more effort in every area, from crews, operational funds, aircraft and dispersal for Strategic Air Command to research on spacecraft, anti-satellite missiles and defensive satellites.

Gen. LeMay said "a majority of SAC

DR. WERNHER VON BRAUN

was grounded for the last five weeks of Fiscal 1957 for lack of gasoline. Others put more emphasis upon near and far future weapons but most USAF witnesses agreed aircraft, missiles and space problems should share about equal priority.

Gen. LeMay and Lt. Gen. Donald L. Putt, USAF Deputy Chief of Staff for Development, testified the U. S. probably would not detect more than one or two ICBMs if Russia fired them at this country now and said even that would be "accidental."

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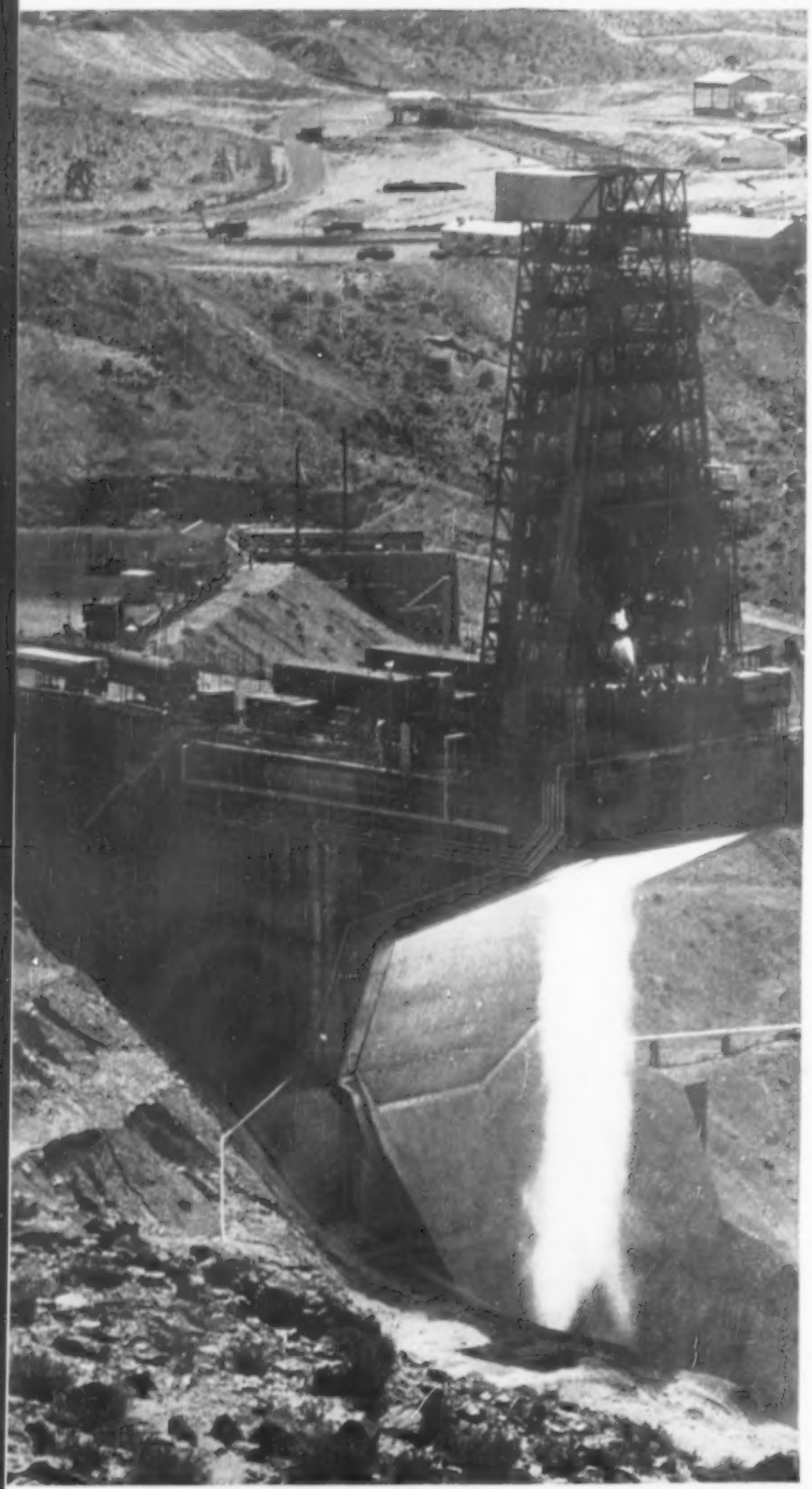

STATIC test firing of Convair Atlas ICBM on stand at Edwards AFB, Calif., shows large flame from main engines, smaller flame above from vernier engine.

SEQUENCE of Atlas firing at Cape Canaveral, Fla., shows details of configuration . . .

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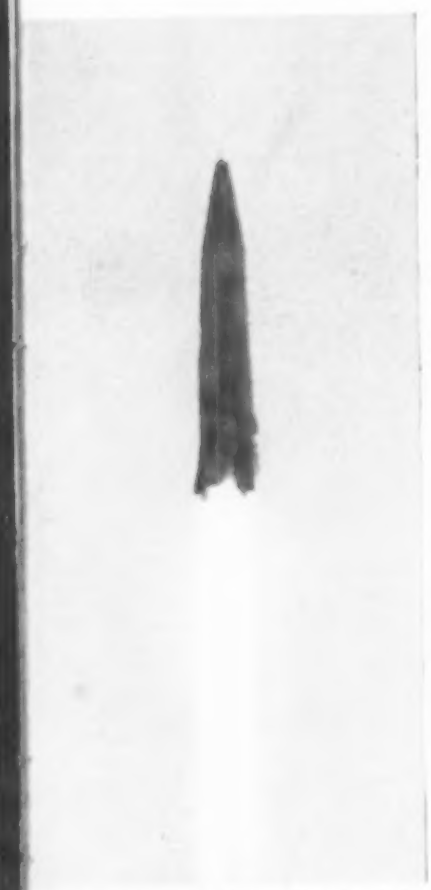
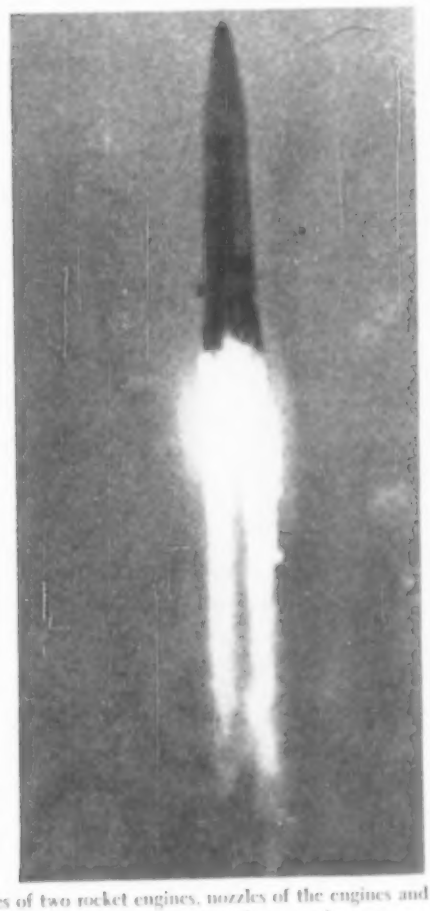
The Atlas propulsion system, Dempsey said, can be adapted for the satellite in less than a year.

The Florida test, announced at the Pentagon, was not a full flight over a 5,000 mile course. The Atlas was reported to have flown a little less than 500 mi. for a test of certain components. The results were satisfactory.

The missile had failed on two other attempts, in June and September.

Speaking at a missile seminar held by the Air Force Assn., Dempsey esti-





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Maj. Gen. Bernard A. Schriever, commander of USAF's Ballistic Missile Division, told the Senate Preparedness Investigating Subcommittee the day of the firing that he is completely confident the Atlas nose cone problem has been licked, based upon exhaustive ground tests and tests with the X-17 missile.

He also indicated guidance and propulsion problems are well in hand.

The Atlas' vernier engines also reportedly operated satisfactorily during last week's firing.

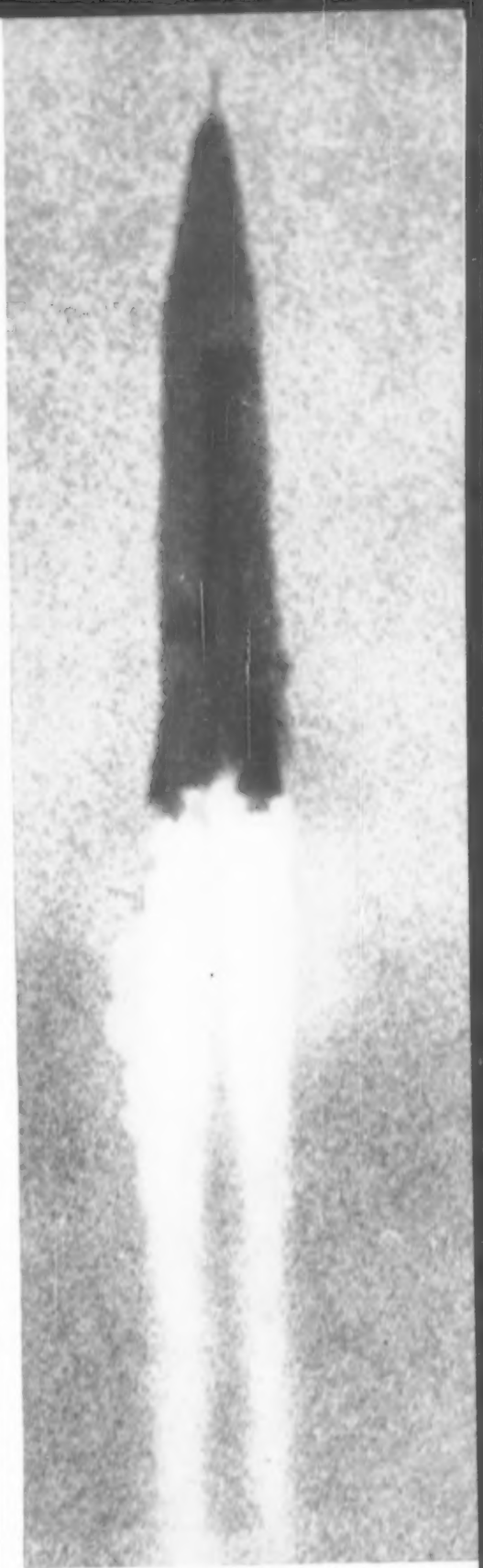
Atlas is 80 ft. long and 10 ft. in diameter (AW Sept. 2, p. 28). Its two Rocketdyne booster engines produce 165,000 lb. thrust each and the sustainer develops 65,000 lb. thrust.

Design features include a corrugated, blunt nose cone to solve the re-entry heat problem and an external guidance package, visible in some of the photos. Length of the nose section, including corrugations, is 9 ft.

Action Log

Washington—Here's the action announced by the U. S. last week in its battle to challenge the Soviet Union's technological propaganda lead:

- **Ordered acceleration of Atlas intercontinental ballistic missile program. Administration will submit supplemental appropriation bill to Congress to cover the Fiscal 1958 acceleration. Atlas funds for Fiscal 1959 will be approximately one-third greater than planned.**
- **Atlas test vehicle makes first successful launching.**
- **North Atlantic Council agrees in principle with U. S. plan for equipping NATO countries with intermediate range ballistic missiles. Under the compromise, countries who do not want the bases can refuse them although they may have signed the agreement.**



ANOTHER detail shown is flared tail of Atlas. Nozzles also show clearly.

Russians Study ICBM Deception By Fragmentation of Final Stage

Russia's missile scientists reportedly are investigating a technique for assisting their intercontinental ballistic missiles to penetrate this country's missile defenses by confusing defending anti-missile radars and computers with large numbers of decoy warheads.

Technique is to separate the missile's final stage rocket from its warhead somewhere near apogee and blast the rocket casing, fuel tanks and motor into fragments with a high explosive charge. Fragments will disperse for miles in front, behind and on all sides of the warhead, with many of the fragments making better radar targets than the warhead itself.

United States scientists developing the Army's Nike-Zeus and Plato and the Air Force's Wizard anti-missile systems have expected Soviet efforts in this direction and are extremely concerned about finding counter techniques. They have been handicapped, however, both by lack of funds and by restrictions placed for security reasons on communication between groups working on closely related parts of the problem.

Counter Techniques

The problem of finding methods of countering decoy warheads is serious. At the extreme altitudes where the final stage rocket would be fragmented, the very thin solar atmosphere would not slow the decoy fragments appreciably.

They would maintain about the same relative velocity as the warhead until slowed by re-entry into the heavier atmosphere about 25 mi. from the target. Also, they would be distributed over an area of several thousand square miles both forward and behind the warhead.

There are three approaches to countering this type of decoy:

• **Detection at re-entry.** The heavier mass of the warhead will cause it to maintain a higher relative velocity through re-entry. The problems, however, of determining which target is the warhead and its interception point, plus launching and guidance of an anti-missile missile against the warhead, approaching from about 25 mi. away at a speed near 15,000 mph., are enormous.

• **Detection prior to decoy launching.** If the approaching missile can be detected and tracked for long enough to compute its trajectory before fragmentation of the rocket, the target following the original elliptical trajectory could be presumed to be the warhead. This technique, however, implies a degree of cooperation from the Soviets that it might not be reasonable to expect.

• **Detection by target analysis.** There have been several proposals both to the Army and Air Force as to methods for analyzing radar return signals from all targets to determine which target is the warhead. To date, no contract has been let for study of any of the various proposed counter techniques.

Security restrictions have seriously handicapped the interchange of information between groups working on the anti-missile missile problem. At least one group of scientists attempting to solve the missile interception problem was not informed of classified National Advisory Committee for Aeronautics reports, published more than two years ago, that describe methods for maneuvering and extending the range of warheads by utilizing the glide potential of a cone shape at speeds above Mach 5.

Their first knowledge of these reports came after declassification from an article appearing in AVIATION WEEK (Nov. 11, p. 26).

Sophistication Needed

A weapon system that would effectively counter an incoming enemy ballistic missile "would be the most difficult development of all time," former Assistant Secretary of Defense Dr. C. C. Furnas told a recent meeting of the American Ordnance Assn., "but a successful result would be so important that the project should be pursued vigorously." All of the problems for the development of such a system have not been solved.

Scientists and military planners working on the problems of missile defense say that much basic study remains to be done. New and highly sophisticated techniques for detection, computation and guidance are mandatory. An effective missile defense system must measure in seconds the time between detection and destruction of any incoming intruder.

Republic Developing Army SD-3 Surveillance Drone

Model depicts all-weather SD-3 surveillance drone which is being developed by Republic Aviation Corp.'s Guided Missiles Division for the Army Signal Corps under a $5 million contract for development and production of the SD-3 and a more advanced jet version of the drone. Vehicle is designated an unmanned flying and spying machine and is called the first of its kind. Army says the SD-3 uses advanced surveillance sensory devices and is equipped with three different interchangeable nose units for performing photography, radar or infrared missions. Drone can be launched at zero length with jet-assisted takeoff, and is reported to be recoverable.

F11F Carries Sidewinder, Area Rule Tanks

Navy Grumman F11F-1 fighter is shown carrying Sidewinder infrared air-to-air missiles and low drag, area ruled fuel tanks under the wing. The auxiliary fuel tank installation was specifically included as a part of the area rule application to the basic aircraft. Sidewinder weighs 155 lbs. is produced by General Electric and Philco, and is in operational use.

Joint Atomic Energy Committee Asks Nuclear Plane Acceleration

By Katherine Johnsen

Washington—Joint Atomic Energy Committee is still dissatisfied with the actions taken to accelerate the U.S. missile and nuclear propulsion programs. The move is another indication of the firm hand Congress will take in directing defense policy in the coming session.

"Much more remains to be done," Rep. Carl Durham (D.-N. C.), chairman of the committee, and Sen. Clinton Anderson (D.-N. M.), vice chairman, wrote the President.

They said, however, they were "pleased to note a somewhat greater recognition by the executive branch of this challenge" posed by Russian advances.

The committee specifically urged President Eisenhower to expand present programs for development of nuclear propelled rockets and aircraft.

Pointing out the military advantages of a nuclear-powered aircraft as a mobile platform for intermediate range missiles, the committee added:

"In terms of world opinion, the psychological advantage of getting the first nuclear propelled plane into the air would be great and perhaps crucial to American scientific prestige."

The Administration recently followed the committee's recommendation in centralizing control of nuclear aircraft projects under USAF Maj. Gen. Donald J. Keirn (AW Nov. 25, p. 28). But, the committee said, further action "in improving program support for efforts to get a prototype flying as soon as possible" is necessary.

Rep. James Patterson (R.-Conn.), a committee member, protested that "This year $100 million was indiscriminately slashed from the nuclear aircraft engine development program and the whole project was down-graded. . . . It was a colossal error. . . ." Patterson promised to push for "a bare-knuckle investigation" by the joint committee next month if the Administration fails to restore the funds cut from the atomic aircraft program to keep under a budget ceiling. This included a sharp reduction in the nuclear aircraft engine program of Pratt & Whitney (AW Aug. 19, p. 34).

The committee urged "full utilization" of the manpower and facilities of the Atomic Energy Commission's Los Alamos and Livermore laboratories in the nuclear rocket development program and asked President Eisenhower to report on steps planned in this direction.

The need for additional facilities for production of atomic weapons also was emphasized. The committee urged that "the Joint Chiefs of Staff revise its method of estimating future requirements in order that these estimates be based on actual projected military requirements rather than being dependent upon AEC available production."

Meanwhile, two top leaders who influence sizable blocs of votes reflected the divergent outlook in Congress.

• **Sen. Lyndon Johnson** (D.-Tex.), majority leader and chairman of the Preparedness Subcommittee now moving forward with a comprehensive investigation of the missile-satellite program (AW Dec. 2 p. 31), called for an all-out spirit of urgency "in stepping into the age of space."

• **Sen. Harry Flood Byrd** (D.-Va.), chairman of the Finance Committee and a high ranking Democrat on the Armed Services Committee, cautioned against any "extravagances" that might affect the country's economic stability.

"Certainly, neither our total governmental expenditures nor our total taxes can be further increased without weakening our economy in inflation and by dangerously stimulating deterrents to increased national production," Byrd warned. "We cannot afford nonessentials in military programs"—or other programs.

Johnson declared that "there is something much bigger and more important in front of us than a few pieces of military hardware"—such as missiles or satellites. "What is really before us is a new frontier—a new age. . . . Rockets to the moon are just over the horizon. Space ships are only a few years away. . . . The scientists are already talking in serious terms about the day when we

will escape the solar system and explore the universe."

Johnson outlined five steps the U.S. should take:

- **"First, we must step** up the development of the weapons which will assure our survival.
- **"Second, we must revise** our methods of teaching and our curricula so that science and technology are no longer ignored.
- **"Third, we must mobilize** our population to face the challenge, tapping the now unused reservoirs of talent and ability among people who are retired.
- **"Fourth, we must** step up our research into the physical and biological problems of outer space—perhaps through a space academy.
- **"Fifth, we must lodge**—either in a new or an existing agency—specific responsibility for the physical, economic and legal problems of exploring outer space."

Power Says Soviets May Strike With Sufficient ICBM Potential

Washington—The chief of the Strategic Air Command warned last week that Russia will attack the U.S. "when they think they are stronger than we are."

Gen. Thomas S. Power indicated the Soviets will consider it time to strike when they have a large stockpile of operational strategic missiles. Most informed observers expect Russia to have this capability by the end of 1960.

Gen. Power, commander of USAF's long range bombers, said he believes SAC today is strong enough to discourage the Soviets from starting a general war. But he warned that the situation may change as Red production of strategic missiles continues.

Blunt Warning

In an address to an Air Force Assn. seminar on guided missiles, Gen. Power gave the bluntest evaluation of Soviet military objectives of any military commander in recent years. His speech, approved by the State Department, was read for him by Lt. Gen. Francis H. Griswold, vice-commander of SAC. Gen. Power's text said, in part:

"It is my considered opinion that as this stockpile (of Russian missiles) grows, so does the threat of general war. . . . The United States has been and still is their major obstacle. It, therefore, stands to reason that the Soviets will make every effort to eliminate that obstacle as soon as they have attained—or believe they have attained—the capability of doing so with impunity.

"Possession of a large stockpile of operational strategic missiles may well give them the conviction that they have attained that capability."

The General pointed out that dictator nations never build a military establishment without using it. He said a realistic appraisal of the Russian machine makes it clear it will be used for aggression against the United States, with no possibility that moral considerations would divert Russia from the horrors of nuclear war.

"They will initiate aggression as soon as they consider it expedient to do so," Gen. Power said, adding that "the Soviet rules will accept even sizable losses in Russian lives and property as long as such losses will not jeopardize their own positions and welfare or impair the achievement of their goals."

'Initiate Aggression'

Our answer to the Russian threat, Gen. Power said, must be a continued power of deterrence. He sees four major difficulties to maintaining this power:

- **Rapid advances in technology.**
- **Improvement in Soviet** aerial defenses.
- **Vulnerability of** SAC bases to attack.
- **Decrease in warning time.**

Already deep in the missile business, SAC's commander said it still is difficult to predict how long it will take for the integration of the new weapons into the Air Force arsenal. He added:

"If our current bombers—the B-47 and B-52—should become obsolete and, therefore, incapable of performing strategic missions against the odds created by advanced technology, before their places can be taken by well-proven missile forces, the resulting gap will weaken our military strength-in-being to such an extent as to actually invite aggression."

At the same time, the General discounted the strategic missile as the "ultimate weapon." He said it has yet to prove itself and that a mixed force of missiles and manned bombers will be used for the "foreseeable future."

Solid Propellant Interest

Air Force has suggested that Phillips Petroleum Co. negotiate with a total of five companies regarding possible affiliation with Phillips' solid propellant activity. The suggestion stemmed from USAF's desire to have Phillips associate its solid propellant work with a firm housing an overall systems and manufacturing capability in the rocket field.

Phillips already is negotiating with North American Aviation's Rocketdyne Division. Other companies on the list:

- **Aeronutronic Systems Inc.**
- **Olin Mathieson Chemical Corp.**
- **Goodyear Aviation Products Division.**
- **Thiokol Chemical Corp.**

Agreement between one of these companies and Phillips probably would lead to the formation of a separate company owned jointly by both firms. Aerojet-General also was interested in negotiating with Phillips, but USAF reportedly considered the company sufficiently busy with solid propellant work.

Russian Air Defenses Called Threat to SAC

New York—Russian chances of neutralizing the Strategic Air Command rest with improving their air defenses rather than with IRBM and ICBM weapons, in the opinion of Walter Dornberger, former chief of German V2 development and other missile projects.

Soviet air defense system of fighters and missiles is currently a potent quantity and Dornberger estimates that its improvement rate is so rapid that within three to five years SAC will have virtually no chance of attacking Russian targets successfully with its present equipment.

Dornberger cites the great difficulties of launching ballistic missiles on a precise time schedule in his contention that it would be almost impossible to destroy all SAC bases and refueling stations simultaneously with these weapons. He believes that a large number of SAC bombers would become airborne after the first warning of such an attack and the Russians would have to depend on their air defense system to save themselves. Dr. Dornberger, who is presently technical assistant to the president of Bell Aircraft Corp., made his points at a recent luncheon at the Overseas Press Club here.

Dr. Dornberger agrees with many experts who have become vocal since the Sputnik launchings in that the greatest need of our missile program is to have strong leaders invested with complete authority over their projects.

He goes further in stating that we should have engineers and not scientists running the ICBM and IRBM projects because they are nothing more than engineering jobs. The necessary knowledge is available to carry them through to completion and the weapons are simply waiting on decisions in his opinion.

Dornberger also commented on the U.S. failure to offer European science a close and active partnership in our defense program. He said that several years ago the U.S. engaged in what was considered by Washington to be a strong attempt to enlist prominent

MB-1 Genie Loaded on F-89J

Practice Douglas MB-1 Genie atomic warhead air-to-air missile is shown before being attached to pylons on Northrop Scorpion F-89J at Vincent AFB, Yuma, Ariz. Genie has four fins with sloped leading edges, horizontal tips and vertical trailing edges for free flight stabilization. The MB-1 travels about 9,000 ft. under power, propelled by an Aerojet General solid fuel rocket (AW July 29, p. 33). Note Canadian insignia on uniform of man at right.

European scientists and engineers for the U.S.-sponsored work. The proposed work required a low level of competency and allowed no exchange of ideas or data concerning the more advanced phases of weapon problems with U.S. scientists.

There was another equally disturbing aspect of the U.S. proposals, according to Dornberger. He found that the representatives of this government who tried to enlist the Europeans were 99% intelligence agents with no scientific background who were primarily interested in completing their dossiers on the foreign scientists.

World Speed Mark Set by F-101 Voodoo

Washington—Thompson Trophy, top U. S. aviation speed prize, was presented last week to a USAF pilot for setting a world record of 1,207.6 mph. over a measured course.

Winner was Maj. Adrian Drew, commander of the 481st Fighter Bomber Squadron, 27th Fighter Bomber Wing, Bergstrom AFB, Austin, Tex. His aircraft was a McDonnell F-101A Voodoo powered by two Pratt & Whitney J57 turbojet engines. The record was set over a measured course at Edwards AFB, Calif.

Drew's flight toppled two old records. Previous world speed record of 1,132 mph. was set in March, 1956, by a British Fairey Delta research plane. The official U.S. record, which won the Thompson Trophy last year, was 1,015 mph. It was set by Comdr. R. W. "Duke" Windsor in a Chance Vought F8U-1 also powered by the J57.

The USAF flight was made over a course measuring 10.1 mi. with a 65 mi. approach on either side. It was flown at an altitude of 39,000 ft. in a temperature of −63 degrees. There were two clocked runs, from west to east and east to west. On the first run, the speed was clocked at 1,212.8 mph. and on the second at 1202.5 mph. for an average of 1,207.6.

Called "Operation Fire Wall," the test followed "Operation Sun Run," in which the F-101 set three new coast-to-coast speed records.

In addition to the Thompson Trophy, other awards presented last week at the annual Wright Day Dinner of the Aero Club of Washington were:

- **Collier Trophy** to Charles J. McCarthy, chairman of the board of Chance Vought Aircraft, and Vice Admiral James S. Russell, former chief of Navy's Bureau of Aeronautics. The prize was given for development of the F8U-1 Crusader, Navy's fastest fighter.
- **Wright Memorial Trophy** to Sen. Stuart Symington (D-Mo.), former Secretary of the Air Force, for his continued service to the cause of airpower.
- **Frank G. Brewer Trophy** for contributions in the field of youth education and training, to Edwin A. Link of Link Aviation Inc. for his work on training devices.
- **General Electric Aviation Trophy** to Capt. Roger E. Sheridan, USAF, for the crew of a Boeing B-47 jet bomber that won "Le Prix des Trois Capitales" race held in connection with the Paris Air Show last May. The aircraft, from the 329th Bomb Squadron of the Strategic Air Command, flew 2,346 mi. in four hours, 12 minutes and seven seconds at an average speed of 558 mph. The course ran from Paris to Madrid and Rome and back to Paris.

Executive Losses Pose Threat to Capital

Departure of Austin may disrupt sales structure; discouraging financial outlook is blow to morale.

By L. L. Doty

Washington—Capital Airlines is undergoing a major top-level staff shakeup that may result in the resignation of at least five of the company's highest-ranking sales officials.

The possible break in Capital's sales structure is the direct result of the recent resignation of James W. Austin as vice president-traffic and sales to accept the presidency of Northeast Airlines (AW Dec. 16, p. 41).

Within 24 hours after Austin's resignation, Nelson Fry, Capital's assistant vice president-traffic, announced his decision to follow suit and accepted an offer to join Northeast as vice president of traffic and sales.

At least three more of Austin's closest aides are known to be seriously considering offers to move into top-ranking positions within Northeast's sales department. Two other sales staff members have definitely declined to make the switch.

Austin Denies Rift

Austin categorically denies that any rift at management level is behind his decision to take a significant part of his staff with him to Northeast. He told Aviation Week that he accepted the Northeast post because the carrier needs a "real sales job" if it is to make a successful bid for a larger share of New England-Florida traffic.

Austin is well known throughout the industry for his effective sales and promotional campaigns and is credited with having spearheaded Capital's introduction of the first domestic aircoach service in the U. S. He was an active participant in the acquisition of Capital's fleet of turboprop Vickers Viscounts and directed the advertising and sales programs that accompanied the inauguration of regular Viscount service.

Management Breach

During the past year, strong differences of opinion within the carrier's top management group have caused sharp breaches between major departments, including sales. Discouraging financial prospects have intensified the strained atmosphere and at least one attempt was made by an executive within the past six months to capture a more powerful management position through a realignment of officer rank.

Although any such move has been successfully rebuffed and management has presented a unified front, internal differences have filtered through to the outside, resulting in a lowering of personnel morale. The threatened departure of the sales staff members is symptomatic of a morale problem that began when it became evident the Viscount was not the panacea it was expected to be.

Austin's leaving probably will not cause any significant change in management structure, but it will have a deep effect upon the company's sales programs since he virtually dictated sales policy. As both a director and officer of the company, he has been a powerful force in Capital's growth pattern during the past 10 years.

However, present financial troubles have forced management to focus attention on steps toward increasing efficiency in operations and maintenance performance and to stress austere economy in other activities. The resultant de-emphasis on sales undoubtedly has had an effect on Austin's influence in the management group.

Financial Hazards

Capital ran into financial difficulty shortly after it began operation of its Viscounts in 1955. That year its net income before special items, including the gain on sale or exchange of aircraft, was only $135,000; the following year, that figure had deteriorated into a $3.7 million loss.

The airline now forecasts a $7.5 million net loss for 1958, $8.7 million in 1959 and $10.9 million in 1960 if no additional equipment is added to its present fleet and the fare structure remains the same. There are no plans for the purchase of additional turbine equipment, although the airline would like to move into a program involving the acquisition of 18 turboject transports.

An order for 14 de Havilland Comets was canceled last spring (AW May 13, p. 39) because of an unwillingness to take on additional debt obligations at its present unsatisfactory earnings rate.

Capital does not now intend to seek financing for the purchase of new equipment, although an attempt to renegotiate its Viscount loans with Rolls-Royce and Vickers-Armstrongs under more favorable terms is under way.

The airline would like to dispose of its 12 Constellation L-49s but has found no satisfactory market for their sale. However, proceeds from any such sale cannot be used for new equipment since, under the terms of its present loans, the funds would have to be applied to the reduction of current indebtedness.

In a move to help rescue Capital from its impending financial crisis, the board of directors last summer named USAF Maj. Gen. David Baker, retired director of procurement and production for the Air Materiel Command, as the airline's president (AW July 29, p. 39). Former President J. H. Carmichael was made chairman of the board.

Baker, thus far, has been unable to arrest the airline's downward financial trend and, since his appointment, Capital has been forced to request the Civil Aeronautics Board for a return to a subsidy status (AW Nov. 11, p. 39).

Baker is now directing all company activities. He has made no major changes in the airline's organizational structure and has successfully buffeted any individual bids for more power within the organization. Carmichael continues to guide policy but, in recent months, has taken a substantially less active part in the airline's operation. As yet, neither Baker nor Carmichael is prepared to make any statements on the reorganization of the sales department. It is unlikely that the sales department, once it is re-established, will carry the influence within the hierarchy that it bore under Austin.

Austin has consistently operated under a rigid budget. For example, during the first six months of 1957, Capital spent .65 cents per passenger on advertising and publicity expense as compared with $1.02 per passenger for American Airlines. The wide spread in expenditures held Austin to less desirable outlets than those used by American but he, nevertheless, was able to sustain a continuous impact in his promotional campaigns.

Since Northeast operates under a strict budgetary policy, Austin apparently plans to re-establish a program at Northeast similar to his Capital program, using personnel who have worked under his tutelage at Capital.

BEA, Industry Both Cool to Jet, Airline Will Soon Agree to Order

London—British European Airways decision on its 1964 short range jet transport is expected any day now after months of delay.

Choice will be made from among three final design proposals: Bristol 200, submitted by Bristol Aeroplane Co., DH 121 from de Havilland Aircraft Co., and the Avro 740 from A. V. Roe and Co. Expected quantity of the order is about two dozen airplanes.

The prospective purchase presents a double paradox: BEA didn't particularly want short range jets and British manufacturers don't particularly want to build them for BEA alone.

The airline has been firmly wedded to the turboprop airplane and BEA's Chairman Lord Sholto Douglas has said that at one time BEA hoped to go on indefinitedly with the turboprop. But BEA's hand was forced, first into preparing specifications for its own short range jet and circulating them, and second, into buying six de Havilland Comet 4Bs as a stop-gap purchase until jets designed for its own needs would become available.

The manufacturers, assured only that BEA might buy up to 24 airplanes designed specifically for the airline's network, were reluctant to tackle the job. Government refusal to subsidize the project meant that each company would have to invest about $50 million in the development of the airplane and would have to sell about three times the possible BEA order to break even.

Other factors have dashed more cold water on the manufacturer's lukewarm attitudes:

• **Capital Airlines** cancellation of its

DC-8 Jet Stresses Passenger Comfort

Three abreast seats of Douglas DC-8 jetliner's first class configuration are as wide as two abreast first class seats currently in service, Douglas says. Mockup shows wide aisles, uncluttered overhead design. Cold air outlets, dining lights and stewardess call buttons are mounted on seatbacks in front of passengers. Utility table position remains level when adjustable seat is reclined. Passengers have reading lights set flush in seat headrests.

14 Comet 4s not only hit de Havilland hard, but tended to give all the companies some doubts about possible world-wide sales of short-range jets. Capital's financial position was not unique, some companies felt, and future financing might be a difficult task.

• **Not all European operators** were convinced that short range jets were necessary even for competitive reasons. Nor were they in a rush to tie up places on some future production lines for an airplane still on paper.

BEA hopes to place these airplanes in service by January, 1964. The airline is demanding economy above all else, but at the same time is asking for seating capacity up to about 100 passengers, a cruise speed of Mach 0.95, a stage length of 1,000 mi. maximum and the ability to operate out of a 6,000-ft. length field on hot days.

Three airframe manufacturers tackled the manifold problems of the proposal. None of them has talked much about a final configuration, probably because it is not yet completely defined. But the common problem for all three has revolved around the type and number of powerplants.

First tendency of the designers was to look at four podded engines, either under the wings in the American style or at the fuselage tail in the new-fashioned French mode. Such engines would have to deliver about 8,000 lb. thrust each for takeoff and would have to be light, small and with low fuel consumption. Engines like that didn't exist, so Bristol and Rolls-Royce started work on their design.

New Powerplants

Bristol developed the B. E. 47 and specified it for one of their short range jet designs. Rolls turned out a proposal for the RB. 140 in about the same thrust category. Both these were new powerplants, in a development sense. It wasn't possible to adopt or scale existing company engines to do the job.

For this and operational reasons, the designers of the airframes looked again at the requirements. Instead of four engines, some of them considered three of higher thrust. Aside from the possible structural trickery needed to install three engines in asymmetrical airplanes, the powerplant became a more-attainable size. Bristol had an Olympus 5s3 variation that might do the job and Rolls was busy scaling its Conway down to the R. B. 141.

The three layouts took shape—with optional geometry—around either three or four engines. Most informed observers believe that each final configuration submitted for BEA technical analysis showed three engines in a rear-fuselage mounting. Two of the engines are mounted on a short pylons at the sides like the Caravelle, and the third is mounted at the base of the vertical fin rather than in the "runway-cleaning" position below the fuselage.

Opinion on the final choice by BEA has swung on a circular path from one company to the other. The reasons cited are many. By introducing the DH 121, say its proponents, BEA's jet fleet logistics would be simplified by the use of planes from a single manufacturer. Alone among the three companies, de Havilland has jet transport experience, gained the hard way.

Bristol Problems

Bristol has been having delivery troubles and teething troubles with the Britannia, and its financial position when all the returns are in for the year may be a bit tenuous. The company's production capacity is tied up with Britannias to a large extent, although phasing in the BEA transport could be a logical follow-on to Britannia production. Bristol engineers would also have a new project in detail design to work on at a time when Britannia detail design was phasing out.

Avro has had considerable experience, much of it bad, in the transport field. But it has not been alone, and to some extent also paid a price for pioneering. The company's recent experience with large multi-jet Vulcan bombers qualifies it for construction of large multi-jet transports in the same performance category. Avro also is the only company to have pronounced loudly its willingness to finance the whole program itself.

Chronologically, the program has had its cycles. Less than two years ago, BEA's chief executive A. H. Milward said BEA would rather do without jets. But second looks at the possible traffic patterns for the late 1950s and early 1960s was disturbing. European carriers would be competing against BEA's turboprops with jet airliners, first the Caravelle and later the big Boeing 707 and Douglas DC-8 series.

This was an unpleasant thought to BEA, and the corporation's technical experts retired to their offices to sweat out the details of a short range jet suited to their own route structure and traffic.

At that time, British Overseas Airways Corp. was still looking for a medium-range jet, and all the prospective manufacturers who received the BEA specifications tried to align them with the BOAC specifications for a maximum economy. But it wouldn't work. Vickers dropped out of the BEA field, preferring to concentrate on the BOAC jet and to leave the BEA problems to other manufacturers.

In the summer of 1956, Capital Airlines announced its order for short range Comet 4As, and this was followed immediately by prodding of BEA to do the same to the continent. BEA didn't react.

But BEA did react when Scandinavian Airways System, route competitor of BEA in Europe, bought its Caravelles from France's Sud Aviation. BEA in a quick decision announced—in time for Farnborough this year—the stop-gap purchase of a fleet of six Comet 4Bs for operations beginning in 1960.

Since then, there has been nothing but silence from the airline. Sales and technical executives of the three companies concerned have had sleepless nights and harried days, waiting for the decision which was, in more or less the words of Avro's Sir Roy Dobson, expected any week now for months.

Biggest risk to the prospective manufacturer is financial. Lack of government subsidy in this project and the small quantity of the order makes it mandatory that the type be sold abroad. But meeting the specific requirements of BEA does not necessarily produce an airplane to delight other airlines.

Hawker-Siddeley group, parent organization of Avro, has officially stated that it would be willing to develop such a short range jet on company funds. Bristol might also be willing to take the same chance. De Havilland, being a smaller group than Hawker-Siddeley, has had some qualms about financing the development, particularly because of the loss suffered as one of the consequences of its pioneering with jet transportation.

De Havilland is trying another kind of pioneering on this job, according to informed sources. The company has proposed that the cost of the development be shared by component manufacturers. Rolls-Royce, for example, would in effect donate the powerplants. Other subcontractors would become partners in the risk with de Havilland, so that the load would be spread.

Regardless of the final arrangements for financing, it is almost a certainty that manufacturing these airplanes for BEA is going to be more productive of prestige than of profits.

ATA Board Members Named to Plans Panel

Washington—Members of the Board of Directors of the Air Transport Assn. last week were named as the Air Transport Panel of the Transportation Assn. of America. Chairman of the Panel is C. E. Woolman, president and general manager of Delta Air Lines.

The Air Transport Panel is one of eight groups in the Transport Assn. of America's national cooperative project, representing users, investors and six forms of transport. Purpose of the panel is to develop proposals for a national transportation policy.

New Routes Recommended for Mid-West

By Ford Eastman

Washington—Extensive additions and improvements in the local air service pattern in seven mid-western states have been recommended by Civil Aeronautics Board Examiner Curtin C. Henderson.

If the recommendations are adopted by the Board, it will fill a void in local service that has existed in North and South Dakota, Nebraska, Iowa, Illinois, Wisconsin and Minnesota, an area which the examiner terms the nation's "bread basket."

He added that the new pattern would cost an estimated $2,506,503 "break-even pay" to local airlines.

Henderson also recommended that Frontier, North Central and Ozark airlines be authorized to provide the major portion of the service.

Examiner's Proposals

His complete recommendations are:

• **That Braniff Airways'** temporary certificate authorizing service to Lincoln, Neb., be made permanent.

• **That Braniff's services** should be suspended at Minot and Bismarck-Mandan, N. D.; Aberdeen; Huron, and Watertown, S. D.; Burlington, Fort Dodge, Mason City and Ottumwa, Iowa; Moline and Quincy, Ill., and St. Joseph, Mo., and also the airline's present route between Des Moines and Sioux City, Iowa.

• **That Braniff's service** at Rochester, Minn., should not be suspended, deleted or transferred.

• **That Frontier Airlines** be authorized to serve for a period of five years between Omaha and intermediate points at Columbus, Lincoln, Grand Island, Hastings, Kearney, North Platte, McCook, Imperial, Alliance and Sidney, Neb.; Sterling, Colo. and Scottsbluff, Neb., and beyond Scottsbluff to Denver; beyond Scotsbluff via intermediate points Lusk and Douglas, Wyo., and the terminal Casper, and beyond the Bismarck-Mandan terminal to Lemon and Spearfish, S. D., Newcastle, Wyo.; Rapid City, S. D.; Hot Springs, S. D.; Chadron, Alliance and Scottsbluff, Neb.; Cheyenne, Wyo.; Sidney, Neb.; Sterling, Colo., and the Denver Airport terminal.

• **That Frontier's certificate be amended** to authorize Minot, N. D., as an alternate intermediate point to Dickinson, N. D., on the airline's present segment between Williston, N. D., and Bismarck-Mandan, N. D.

• **That these route segments** should be authorized subject to the condition that Frontier be allowed to overfly any intermediate point on flights over all or part of the Omaha-Denver-Casper segment and the Bismarck-Mandan-Denver segment if each intermediate point on the first segment are served by at least two daily round trips between terminals and the second by two daily round trips from Denver.

• **That Frontier may overfly Alliance,** Scottsbluff, Sidney and Sterling on flights over all or part of the Omaha-Denver-Casper segment or the Bismarck-Mandan-Denver segment provided that the points are served on at least two daily round trips to Denver whether operated over either segment of the route.

• **That Frontier** may overfly Imperial, Nebr., on flights over all or part of the Omaha-Denver-Casper segment provided it is served on at least one daily round trip to Denver.

• **That Frontier** shall schedule service to a minimum of two intermediate points on flights between Denver and Omaha and between Denver and Rapid City.

• **That North Central Airline's** route No. 86 be amended as to authorize service: Between Minot, N. D., and Minneapolis/St. Paul via Bismarck-Mandan, N. D., Aberdeen, Huron and Brookings, S. D.; between Sioux Falls, S. D., and Minneapolis/St. Paul via Mitchell, Huron and Watertown, S. D.; between Sioux Falls and Minneapolis/St. Paul via Worthington and Mankato; between Grand Forks, N. D., and Omaha via Fargo, N. D.; Watertown, Brookings, Sioux Falls, Yankton and Sioux City, S. D., and Norfolk, Neb.; between Bismarck-Mandan and Minneapolis/St. Paul via Jamestown and Fargo-Moorhead, N. D., Fergus Falls and Alexandria, Minn.; between Minneapolis/St. Paul and Minot via Brainerd, Bemidji and Thief River Falls, Minn., and Grand Forks and Devils Lake, N. D.; between Minneapolis/St. Paul and Milwaukee, Wis. via Eau Claire, Marshfield and Appleton, Wis. Also, Ashland, Wis. should be added as an intermediate point on North Central's route between the cities of Duluth Superior and Ironwood, Mich.

• **That the certificate held** by Ozark Airlines be amended to authorize service between Minneapolis/St. Paul and Davenport, Iowa/Moline, Ill., via Rochester and Austin/Albert Lea, Minn., Mason City, Waterloo and Cedar Rapids, Iowa; Sioux City and St. Louis via Des Moines, Ottumwa and Burlington, Iowa, and Quincy, Ill.; Omaha and the intermediate points Lincoln and Beatrice, Nebr., beyond Beatrice to Topeka, Kans., and Kansas City, Mo., and beyond Beatrice to St. Joseph and Kansas City, Mo.; Chicago and intermediate points Rockford, Ill., Dubuque, Waterloo, Mason City and Fort Dodge, Iowa, and beyond Fort Dodge to Sioux City, Iowa, and beyond Fort Dodge to Omaha, Neb.; Des Moines and Iowa City and beyond Iowa City to Dubuque and Chicago and beyond Iowa city to Clifton, Iowa, and Chicago; Minneapolis/St. Paul and Des Moines via Rochester, Minn., Mason City and Fort Dodge, Iowa; Des Moines and Chicago via Ottumwa and Burlington, Iowa, and Peoria, Ill.; Chicago and Kansas City, Mo., via Davenport, Iowa/Moline, Ill., Burlington, Iowa, and St. Joseph, Mo.

• **That these route** segments on both Ozark and North Central's system should be authorized on the condition that after each intermediate point has received two daily round trips it may be overflown on flights over a part or all of the segment—except that on flights between the local carrier's terminal points that are served by a single trunk airline, a minimum of two intermediate points shall be served.

• **That Northwest Airline's** service at Jamestown, N. D., be suspended.

• **That United Air Line's** service at Iowa City, Iowa, Grand Island, North Platte and Scottsbluff, Neb., be suspended.

• **That the service of** Western Air Lines at Alliance, Chadron, Scottsbluff, Neb., Brookings, Hot Springs and Spearfish, S. D., and Mankato and Rochester, Minn., be suspended by the airline.

Area's Growth

Examiner Henderson added that the area has experienced a substantial and dynamic growth in manufacturing and commercial productivity within the past decade as well as impressive rises in population per capita wealth and buying power.

On the other hand, he said, the area may well be characterized as considerably isolated because of the great distances between the cities and their primary communities of interest centers and traffic gateways, inadequate surface transportation and inaccessible highways caused by snow and ice.

Henderson said the Seven States Area represented the largest void in local-service air transportation in the U.S. when compared with many areas where local service routes have been operated for more than a decade. Under his recommendations, air transportation would be authorized to many cities for the first time in the Dakotas and Nebraska where existing transportation facilities are inadequate.

Indian Airline Tests Noratlas

Noratlas 2508 which currently is undergoing tests in India is powered by Pratt & Whitney R2800 CB 17s developing 2,500 hp. Usually the Noratlas is powered by Bristol Hercules engines built in France by Snecma. The 2508 also uses Hamilton Standard 43E60 three-bladed propellers. Because of its use in areas where landing altitudes are substantially above sea level, the 2508 also is equipped with wingtip Turbomeca Marbore jets developing about 880 lb. thrust each. The 2508 in photo is being tested by private Indian airline, Kalinga, which hopes to establish a route between Calcutta and Lhasa, Tibet. An agreement approving this link already has been worked out between the Indian and Red China governments. Route will have to be flown at altitudes of 21,000-23,000 ft. with requirement that 19,000 ft. altitude can be held on one engine. If tests prove satisfactory, Kalinga probably will buy from four to six Noratlas 2508s.

Night Coach Fare Cut Proposed by National

Washington—National Airlines last week petitioned the Civil Aeronautics Board for a 20% reduction in night coach fares between five northern cities and six Florida points on its route. The proposed fares would be applicable only on certain days of the week.

Walter Sternberg, senior vice president traffic and sales, said the plan was made in an effort to broaden and balance Florida vacation travel demand. He pointed out that demand for space is high during weekends and lower during weekdays.

National asked for an experimental excursion coach fare for departures after 10 P.M. from Boston, Philadelphia, New York, Newark or Washington on Sundays, Mondays and Tuesdays to Jacksonville, Orlando, Tampa, St. Petersburg/Clearwater or Miami.

Return trip under the excursion fare would have to be completed within 16 days using night coach service from Florida on Tuesdays, Wednesdays or Thursdays. Effective dates would be from Jan. 13 to May 30, Sternberg said.

"Based on our experience," Sternberg said, "we believe that National's plan will effectively level traffic and give those who can do so an inducement to travel on other than weekend days. This in turn will help tourist attractions and accommodations in the areas which we serve to level out their guest bookings and thus improve their mid-week status."

Sternberg added the proposed fare is in no way related to the various fare proposals now before the CAB in which domestic airlines are seeking a fare increase. He added however, that National believes part of the problem of rising costs can be met with efforts to increase revenues when that can be done by selling seats that would otherwise be flying empty.

Subsidy No Solution, Smith Tells Forum

New York—Government subsidy should no longer be available to domestic trunklines, American Airlines President C. R. Smith told insurance company executives at a recent transportation investment forum here.

Smith said the trunks would be better off in the long run if the government adopted a non-subsidy policy for them and spelled out the policy clearly and unequivocally.

Trunkline operations, the American official said, have reached a point where, with sound management and sound regulation, self-sufficient operation should continue to be possible for the future. Reduction of subsidy in all areas of air transportation should be encouraged, but availability of subsidy to overseas carriers and local service airlines should be retained in the public interest.

Subsidization of one carrier on a route served by several carriers would seriously change the competitive situation, Smith said. Carriers who formerly competed among themselves on an equal basis would find themselves competing against a carrier partly underwritten by the treasury of the federal government.

Some lenders of capital might consider the risk less if repayment is guaranteed through the need section of the Civil Aeronautics Act, Smith said, but this may not be a sound view. Lenders deal with many airline companies, and guaranteeing one loan would be of little comfort if other loans were damaged by subsidized competition.

Regarding local service carriers, Smith said it would be difficult for them to make a living in serving smaller cities without federal help. Because they provide a useful service, reasonable aid should continue.

Subsidy should not be provided, however, to underwrite local service competition on routes adequately served by subsidy-free carriers, according to Smith.

New Stock Program Proposed for Hughes

Washington—Settlement of the Hughes-Trans World Airlines-Atlas-Northeast Airlines possible common control case appeared probable last week following a new proposal involving Hughes voting stock.

The proposal—that the parties involved, including the CAB staff, indicated was acceptable—would permit Hughes to retain his stock in Atlas, which holds a 51% interest in Northeast, but a designated bank or trust company would vote the stock in matters concerning the airline. Hughes also controls TWA through his interest in Hughes Tool Co.

An earlier agreement was turned down by Civil Aeronautics Board Examiner Paul N. Pfeiffer on the grounds it did not establish an irrevocable voting trust for Hughes Atlas stock. Pfeiffer said that, under the previous proposal, Hughes would have been free to revoke the voting trust at will as a matter of law. The CAB began the proceeding to determine if Hughes' Atlas stock had given him control of Northeast without prior Board approval.

Burton Named to Head Washington National

Washington—L. W. Burton, director of the Civil Aeronautics Administration's Office of Plans and Development, was named director of Washington National Airport last week by CAA Administrator James Pyle. Effective date of the appointment is Feb. 1.

Burton, who has operated airports at Orlando, Fla., and San Juan, Puerto Rico, will succeed Bennett Griffin, who is retiring from CAA after 26 years of government service, the last 10 as director of Washington National.

SHORTLINES

► **American Airlines** will begin nonstop service between Chicago and Mexico City on Jan. 5—the first nonstop service between the two points by an American carrier. The daily flight will be made by a Douglas DC-7 in combined first class-tourist configuration. The airline plans to accommodate 32 "Mercury" passengers and 38 "Royal Coachman" passengers on the same aircraft. American plans to schedule the daily Chicago departure at 12:20 P.M., with arrival at Mexico City at 6:15 P.M. Departure from Mexico City will be at 11:55 P.M., arriving in Chicago at 5:40 A.M.

► **Flying Tiger Line** and the Military Air Transport Service have renewed a contract under which Flying Tiger has been providing basic commercial airlift between the U. S. and Japan. During the last six months, the airline has provided nearly $7 million in transportation, made a total of 184 round trips, flown nearly 25,000 passengers a total of 336,250,000 passenger-miles and carried approximately five million lb. of cargo. The new contract extends the service for another six months.

► **Trans World Airlines** claims a new record for pounds of mail carried overseas in one day. TWA flew 61,000 lb. of mail to Europe on Dec. 13, including 23,000 lb. of Christmas mail to Army personnel in Frankfurt which was flown in an all-mail Lockheed Super-H Constellation. The remaining 38,000 lb. was carried on nine regular passenger flights to London, Rome, Madrid, Zurich, Geneva, Milan and Athens.

► **Universal Airlines** and United States Overseas Airlines, supplemental carriers, were granted permission by the Civil Aeronautics Board to operate 10 extra flights each between New York and Miami and Chicago and Miami to handle holiday traffic from Dec. 18 to Jan. 5.

► **Trans World Airlines** will begin regular scheduled flights to Bangkok and Manila Jan. 1. With the opening of the new route, round-the-world flights through connections with Northwest Airline at Manila will be possible.

► **Convair** has awarded a $250,000 contract to Burton Rodgers-Technical Training Aids Inc. to build a cockpit procedure trainer for the 880 turbojet transport.

► **Airline business** settled through the International Air Transport Assn. Clearing House at London during the first nine months of 1957 showed a 32% increase over the same period last year.

AIRLINE OBSERVER

► Available seat-miles on domestic scheduled carriers will hit a new high during the year 1957. As of November, available seat-miles for the year had increased 18.1% over the same period last year when the increase was only 12.2%. Airline load factors dropped 3.52 percentage points during November as compared with the same period of 1956. Load factor for the month was 55.33% as compared with 61.6% for the year. The monthly decline follows a downward trend that has been evident since a reversal first took place in April, 1956. Indications are that the increase in revenue passenger-miles will reach about 12% over that of last year.

► **American Airlines reports declines in all traffic categories during November as compared with the same month of 1956. Passenger-miles flown dipped over 4% and air freight showed a 12% drop. Mail was down 4.4%, and express fell 19% below the November, 1956, ton-mile figure.**

► United Air Lines will purchase an additional 40 Boeing 720 jet transports to bring its total to 51. In addition to the Boeings, United has 40 Douglas DC-8 turbojets on order.

► **Pilots of five scheduled airlines were in the process of taking strike votes last week. Pilots at American, Central, West Coast and Western Airlines are in conflict over pay rates and working conditions. Pilots of Eastern Air Lines are voting on the crew composition issue, a controversy over whether flight engineers or pilots shall serve as crew members on jet transports (AW Dec. 2 p. 45).**

► Edward Slattery, Civil Aeronautics Board information chief, has been moved into the CAB library on special research assignment which has all the earmarks of a second attempt to strip him of his present title. Slattery was returned to his present position when James Durfee was made chairman after having been removed from the office several months earlier. At the Civil Aeronautics Administration, Levings Willis, chief of the press branch has been relieved of duty after his position was abolished. Raymond Nathan, press and information officer, has resigned after refusing to accept a transfer to Kansas City. Charles Planck, a senior staff member in the Washington press office, accepted a transfer to Anchorage, Alaska, as a press and information officer.

► **Soviet Union is especially pleased with the comparison of Moscow-Copenhagen service by Aeroflot's Tu-104 turbojets and Scandinavian Airline System DC-6s because it will give the prestige-conscious Russian carrier a larger flying time advantage over SAS than it has enjoyed. Russians say their Il-14s made the trip in about five hours. Now, the Soviets claim, "our Tu-104s will fly from Moscow to Copenhagen in 2 hr. 25 min., compared with 4 hr. for the SAS DC-6s."**

► Prospects are bright for a closer alignment of U. S. and British performance requirements for transport aircraft. In a special meeting at Washington, aviation representatives of both countries agreed on basic steps to be taken toward establishing similar performance codes to permit each country to validate the other's aircraft certificates without requiring special conditions or costly flight testing.

► **New York Airways entire fleet of three Sikorsky S-58 and five S-55 helicopters is being offered for sale as a $1.5 million package with spares, tools and advisory service. The airline last week signed an agreement with William C. Wold Associates, New York brokers, to handle the sale. New York Airways is considering a switch to Vertol 44B equipment (AW Dec. 16, p. 40).**

► Despite last-minute delivery delays necessitated by a wiring system modification, the long-range Bristol Britannia last week made its first commercial appearance in the U. S. Aeronaves de Mexico was forced to fly its New York-Mexico City inaugural schedules Dec. 16 with a Constellation leased from TWA but had the Britannia on the route by Dec. 18. British Overseas Airways Corp. was scheduled to begin Britannia London service later last week. Both airlines postponed press flights because of the delay.

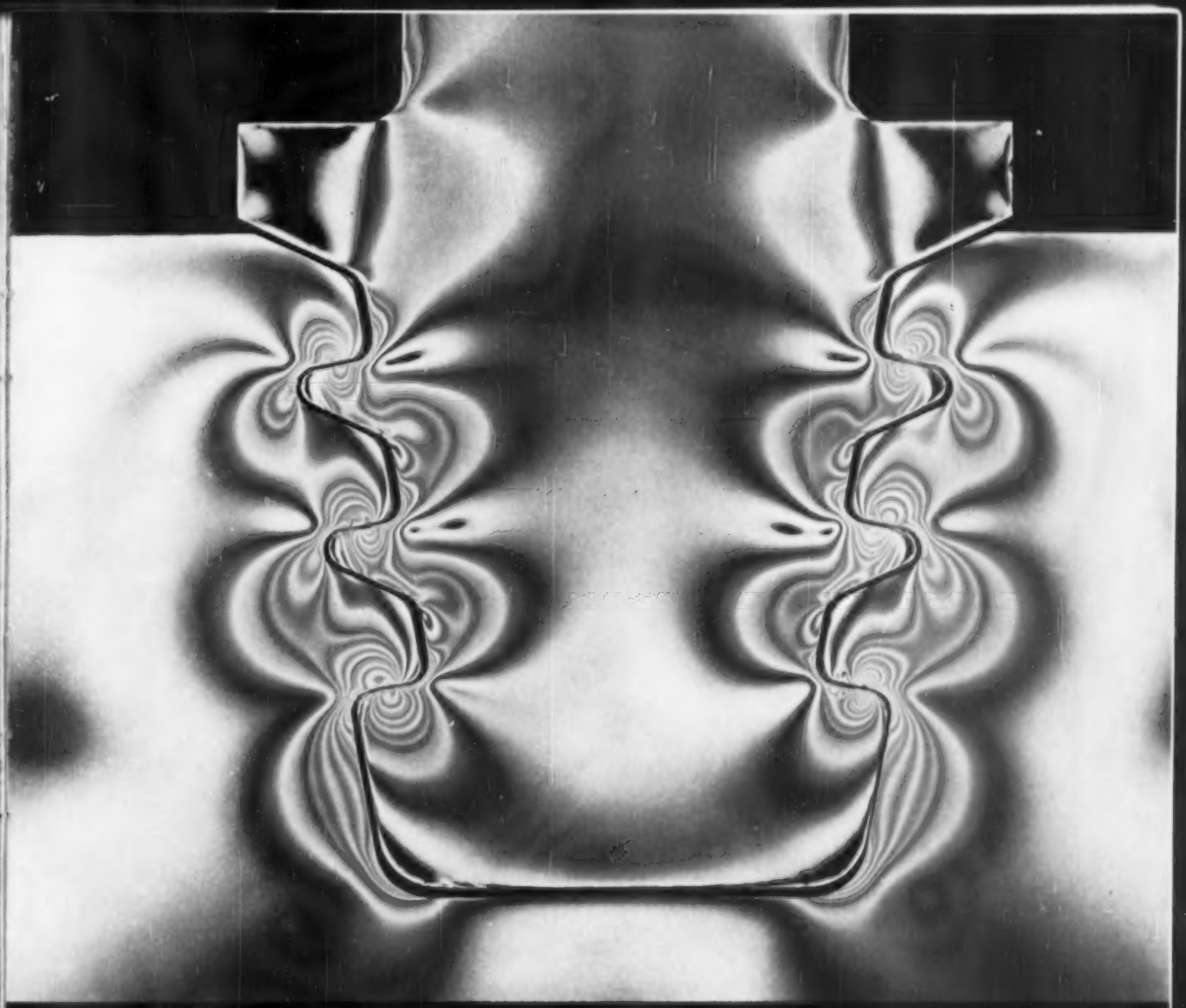
Airline Income and Expenses — Third Quarter, 1957

(IN DOLLARS)

	Passenger Revenue	Mail Revenue (U. S.)	Property Revenue	Charter Revenue	Federal Subsidy	Total Operating Revenue	Total Operating Expenses	Net Income (Before Taxes)
DOMESTIC TRUNK	$70,022,262	$1,557,675	$6,268,034	$101,839	$11,111	$78,224,796	$72,161,991	$6,259,748
American	12,900,166	310,940	697,703	113,664		14,074,952	12,941,447	953,367
Braniff	23,911,379	512,468	890,150	14,538		25,488,494	25,094,072	−478,920
Capital	6,154,491	135,175	268,975			6,636,028	6,303,304	329,143
Continental	17,079,305	371,471	1,058,874	195,381		18,794,871	18,215,527	466,329
Delta	52,622,831	812,669	2,137,756	3,794		55,982,545	55,621,183	297,423
Eastern	9,334,041	209,268	582,250	30,531		10,384,173	10,623,800	−259,150
National	4,613,650	58,935	181,124	4,919	270	4,885,397	5,764,947	−867,553
Northeast	14,434,255	378,235	1,078,517	8,126		15,990,363	14,275,059	1,818,076
Northwest	52,595,254	930,417	2,173,420	52,080		56,563,486	53,694,997	2,928,997
Trans World	68,401,015	2,268,673	5,120,368	469,706		76,880,535	67,279,653	9,168,305
United	10,854,120	242,461	422,494	16,158		11,595,244	9,336,667	2,060,481
Western								
INTERNATIONAL	1,352,223	16,126	212,441		20,000	1,643,285	1,421,890	221,194
American	2,052,842	30,354	213,999			2,353,414	2,165,592	156,626
Braniff	446,250	5,426	15,669	9,376		491,383	432,870	58,547
Caribbean-Atlantic	1,618,085	13,361	107,798			1,746,549	1,428,083	301,609
Delta	5,219,681	96,546	174,863	102,439		5,605,061	4,880,013	895,071
Eastern	706,011	13,229	40,635	11,701		772,866	771,467	−1,746
National	5,635,220	1,363,034	863,348	33,467		8,171,136	6,347,472	2,944,132
Northwest								
Pan American	1,478,945	59,334	196,882	41,662		1,782,814	2,113,602	−326,358
Alaska	35,274,113	1,620,620	2,990,164	896,556		41,232,632	32,816,684	8,384,239
Atlantic	19,767,831	537,562	4,212,442	616,195		25,819,189	24,644,137	1,556,957
Latin America	16,821,048	1,218,261	2,155,199	1,130,866		22,119,872	19,073,391	3,096,863
Pacific	3,804,849	116,089	641,145	66,704		5,229,004	4,900,393	819,480
Panagra	19,853,188	1,227,969	1,209,889	353,586		23,277,591	19,209,787	3,916,949
Trans World	4,470,426	99,579	65,922	12,000		4,695,401	3,370,068	1,298,877
United	285,716	1,455	2,237			290,639	425,400	−68,142
Western								
LOCAL SERVICE	1,567,534	32,531	82,725		502,520	2,197,039	2,244,265	−56,428
Allegheny	507,009	7,365	19,649	21,050	332,432	892,048	947,084	96,000
Bonanza	408,000	11,000	22,000	29,000	572,000	1,049,000	1,148,000	−102,000
Central	989,000	26,000	93,000	18,000	546,000	1,683,000	1,587,000	8,877
Frontier	433,212	12,128	24,000		455,716	925,801	907,416	−142,931
Lake Central	1,453,701	15,980	76,391	22,874	341,422	2,431,435	2,185,170	175,128
Mohawk	2,227,858	57,124	58,923	62,761	443,073	2,858,333	2,935,422	−87,995
North Central	1,174,367	29,099	61,465	17,955	673,003	1,960,146	1,970,186	−26,915
Ozark	1,483,900	25,599	51,723	14,868	625,338	2,246,146	2,085,810	203,043
Piedmont	592,406	23,390	18,666	15,975	493,459	1,147,518	1,153,564	−7,792
Southern	1,080,868	27,983	25,121	43,532	447,285	1,630,304	1,470,723	138,232
Southwest	875,557	28,757	53,821	16,131	745,362	1,738,147	1,644,470	95,725
Trans-Texas	709,179	12,617	20,892	6,025	390,014	1,142,010	1,120,689	14,772
West Coast								
HAWAIIAN	1,557,268	8,259	199,369	11,339		1,816,294	1,580,948	209,563
Hawaiian	756,621	3,025	33,522	5,579		824,948	728,521	92,486
Trans-Pacific								
CARGO LINES			439,762	38,442		491,276	481,112	1,131
Aerovias sud Americana		20,333	2,149,710	7,195,036		9,466,631	8,969,188	1,319,516
Flying Tiger		22,852	1,416,370	62,452		1,489,215	2,077,037	−564,095
Riddle			849,362	4,411,815		5,255,314	5,575,359	−366,615
Seaboard & Western		47,229	1,941,625	3,133,395		5,139,488	5,456,650	478,222
Slick								
HELICOPTER	98,180	17,051	1,252		233,689	351,878	415,362	−81,492
Chicago Helicopter	52,571	29,373	20,488	1,067	238,807	342,987	298,783	42,879
Los Angeles Airways	160,931	14,195	15,333	18,405	527,506	760,605	655,560	99,578
New York Airways								
ALASKA	495,351	136,948	226,919	263,285	278,940	1,416,840	1,505,033	−180,408
Alaska Airlines	252,628	26,487	34,695	44,252	95,259	462,005	378,575	80,780
Alaska Coastal	43,460	27,773	23,854	321,332	45,489	467,455	427,540	26,936
Cordova	203,166	14,828	24,055	286,611	65,524	339,926	284,431	54,789
Ellis	2,219,444	182,439	293,940	18,296	228,372	2,966,253	2,585,840	336,305
Pacific Northern								

* Not available.

Compiled by AVIATION WEEK from airline reports to the Civil Aeronautics Board.



THE ROOT OF THE MATTER

Orenda is pioneering many new concepts in jet engine design. The IROQUOIS supersonic turbojet, now producing over 20,000 lbs. (dry) thrust in its early development, incorporates several. The outstanding performance of the IROQUOIS, combined with inherent low weight, is the reason it has been selected for the Avro Arrow, Canada's new supersonic interceptor.

Illustration shows stress patterns in a jet engine blade root under load, using color photography and photo-elastic stress analysis.

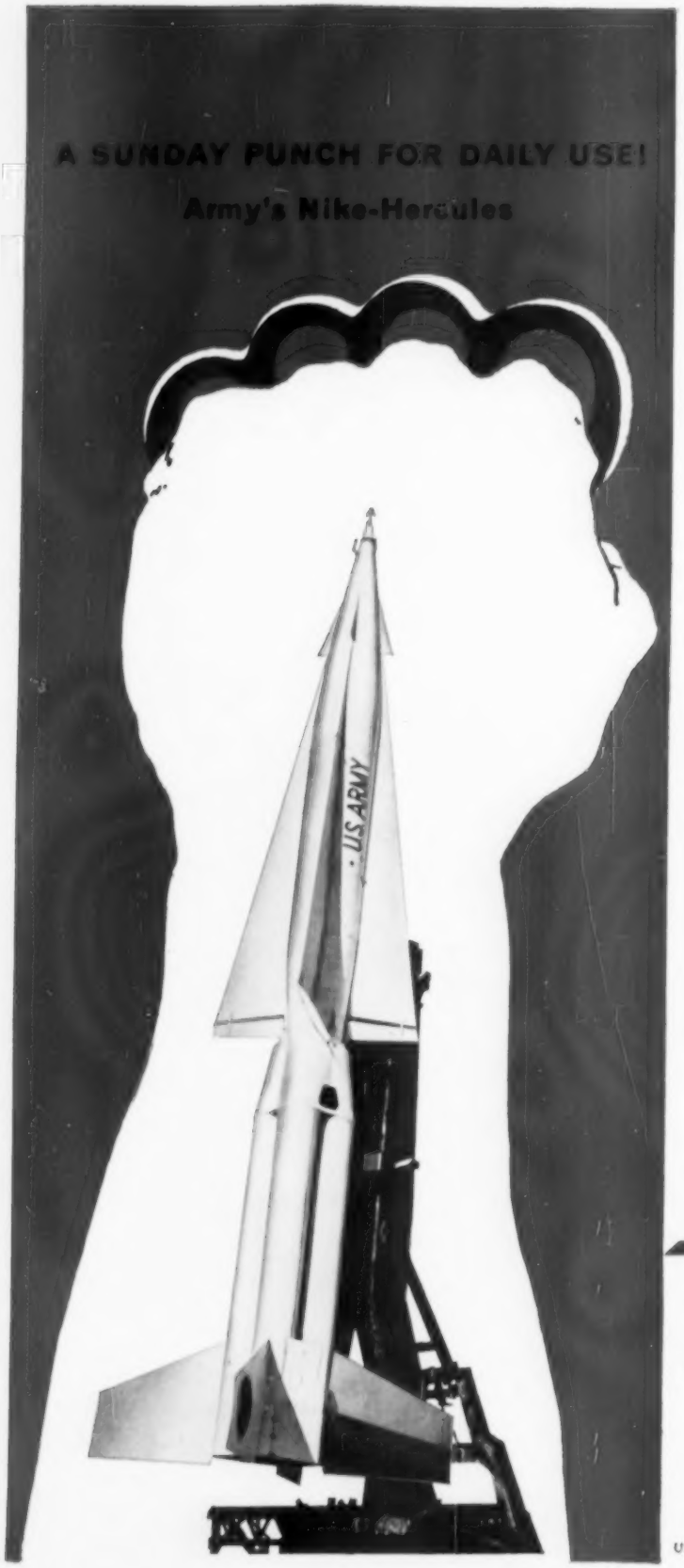
ORENDA *ENGINES LIMITED*

MALTON, CANADA

MEMBER: A.V. ROE CANADA LIMITED & THE HAWKER SIDDELEY GROUP

A SUNDAY PUNCH FOR DAILY USE!

Army's Nike-Hercules



An Army missile with a lethal wallop, the Nike-Hercules will deliver a knock-out blow to enemy air aggression—Sunday and every day, around the clock. Nike's knuckle-duster is its warhead—loaded and tested, developed and delivered by Aerojet-General's Explosive Ordnance Division.

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THE GENERAL TIRE

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U.S. ARMY PHOTOGRAPH

Solid Fuels May Claim Big-Missile Field

By Russell Hawkes

Redlands, Calif.—Solid fuel rockets will play an important, if not dominant, role in the large-missile field, according to staff members and officials of Grand Central Rocket Co. here.

H. L. Thackwell, assistant president, points out that the only limit to the size and power of a solid propellant rocket is set by the means of transport from factory to pad. Even this limit could be overcome by building the case and casting the charge in the launching area, since relatively little manpower or floor area is needed.

Despite the ease with which big solid propellant motors can be built, Thackwell reports that multiple stages or clusters of rockets are a more probable response to demands for range, altitude and speed. Since growth factor in a rocket is the cube of an increase in payload (to a powerplant designer, payload is anything not connected with propulsion) rather than a linear function as it is in aircraft, designers welcome the chance to drop off expended motors, thereby increasing the ratio of propellant weight to weight of inert parts in the later stages of powered flight.

Bucking a Trend

According to Charles E. Bartley, president of the company, Grand Central will buck the current trend in the industry to develop "systems capability" covering design and production of every component in the missile. The company's attitude is that formulation of its own propellants would cause prejudices that would limit freedom to pick the best fuel for the job regardless of its origin.

To go into the airframe or guidance businesses would be to compete with their own customers. Bartley regards this as a useless risk since the company is doing quite well as a powerplant supplier. At the moment, Grand Central is not seeking contracts for the design of a whole missile unless it is nearly all engine with only rudimentary airframe or guidance.

Estimating progress of the rocket design art, Thackwell said that with solid propellants it would be possible to put an American rocket on the moon within a year. In five years, a manned satellite could be in its orbit and an unmanned rocket could hit Mars. A manned, solid fuel rocket could be on the moon in 10 years.

A trend toward solid propellants for big rockets is beginning to mature. Chief reasons for this are the military advantages offered by:

- **Reliability.** Once through its development program, a solid propellant rocket can be expected to give virtually 100% reliability.
- **Economy.** The result of good reliability is a cut in the number of rockets which must be produced to destroy a target.
- **Ease of handling.** This simplifies logistics due to a smaller list of ground equipment required, smaller manpower requirement, fewer parts to be maintained, etc.
- **Short count-down.** A solid fueled rocket stands on the pad in firing condition; it can retaliate within minutes or seconds of the first detection of an attack. This minimizes the danger of its being destroyed on the pad. Storable liquid propellants intended to have the same advantage are making progress in the laboratory but are not expected to reach an operational stage for some time.

Less well known than these advantages is the fact that solid propellants can at least compete in performance with liquid propellant rockets if not exceed them. Thackwell points out that solid fueled rockets hold the speed and altitude records this side of the Iron Curtain.

It is true that liquid propellants have a margin of specific impulse in their favor but this gap has narrowed in recent years. Also, when the proportion of payload to propellant weight is small (10% or less), performance is more responsive to changes in the mass ratio (propellant weight to gross weight minus propellant) than to changes in specific impulse.

The reason for this is evident in the formula for drag-free burnout velocity in horizontal flight:

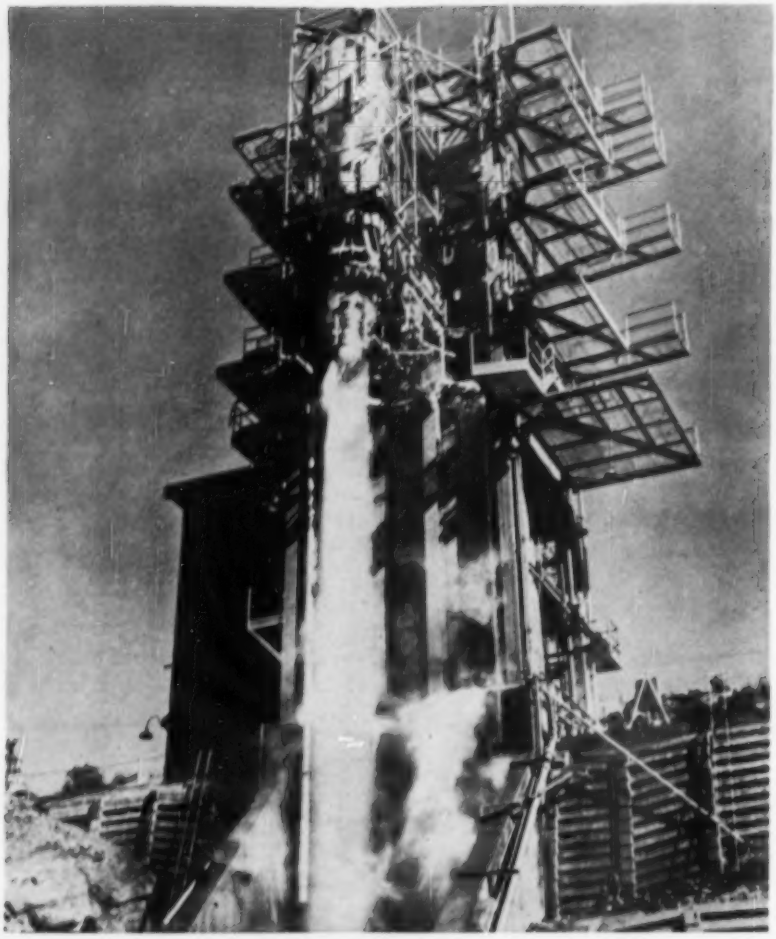
$$V_b = I_{sp} g \log (1 + W_p/W_s)$$

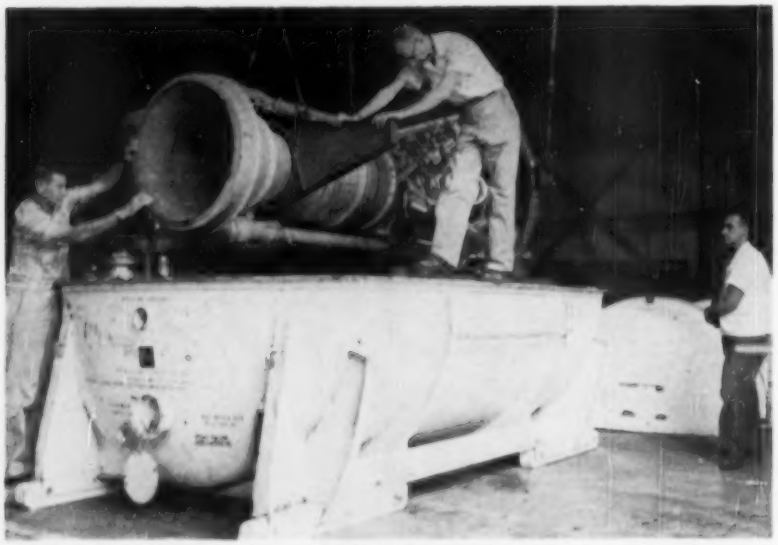
The burnout velocity, V_b, is a direct function of I_{sp}, the specific impulse, and a logarithmic function of W_p/W_s, the mass ratio.

Ratio Advantages

The advantage of solid fuel rockets in mass ratio is due to two things: solid propellants are usually about 70% more dense than liquid propellants, and the inert weight of powerplant accessories like fuel pumps and controls and coolant systems is not needed. Thackwell predicts that the biggest strides in solid

BRAMLEY-BEKEN propellant mixer being installed at Grand Central's Redlands plant cost $100,000, is said to be largest in country. Unit will be in operation by mid-January.





Rocketdyne Tests, Delivers Redstone Engine

Redstone rocket engine delivers more than 75,000 lb. thrust while undergoing static test at Rocketdyne's propulsion field laboratory site near Los Angeles (above). Up to 10 consecutive full-power runs were made in early test program with single engine assemblies, company claims. Army Ballistic Missile Agency personnel unpack Redstone Rocketdyne engine at Redstone Arsenal, Huntsville, Ala., after delivery from Canoga Park, Calif. (below).

fuel rocket performance in the next five years will result not from the perfection of super fuels but from the application of known techniques to reduce the weight of case, nozzle and other inert parts, thereby increasing mass ratios.

Grand Central claims the first systematic approach to optimizing design of solid propellant motors and to this is attributed the winning of a design and production contract for Vanguard Stage 3. Thackwell calls this the highest performance solid fueled rocket successfully tested in this country.

The Grand Central approach to optimization is essentially the weapon system concept used to prevent engine design parameters from being subordinated to airframe or guidance parameters without early consideration of the performance sacrifices entailed.

Grand Central engineers decry the idea that off-the-shelf engines or engines designed for some other application can be used in other cases without causing important performance losses.

Design Rules

Thackwell has stated three general axioms to be observed in designing an optimum performance rocket:

- "**Enable** the missile designer to coordinate the rocket motor development as well as the development of the rest of the missile.
- "**Allow** the solid propellant motor designer the greatest possible latitude with regard to motor diameter and burning time.
- "**Remember** that the lightest solid propellant rocket motor is not necessarily the best one for the job."

To get maximum performance and efficiency the engine designer must be free to juggle a number of variables including: diameter, slenderness (length to diameter ratio), charge port (hollow center) cross-sectional area, nozzle throat area, combustion pressure, burning rate, burning area, radial burning distance (from original port surface to case) and burning time, propellant formulation, charge configuration, etc. Failure to coordinate powerplant development with that of the rest of the missile may present the engine designer with crippling restrictions on how he can vary such factors.

Burnout Velocity

Velocity at burnout controls range and altitude if there are no wings to add aerodynamic lift making it the best single measure of rocket performance. The responsiveness of burnout velocity to mass ratio is less significant when payload is a large part of gross but is extremely important in an ultra-high performance missile with a relatively small payload. It is even possible for a lighter rocket with higher specific im-

pulse and a better ratio of total impulse to weight to have a lower maximum velocity and shorter range than another heavier rocket with lower specific impulse and impulse/weight ratio but better mass ratio. An efficient, high mass ratio design may not be possible with a high specific impulse propellant if it lacks density or the right burning rate characteristics needed for the desired impulse and burning time in the necessary light motor case.

Design Relationships

The juggling of motor dimensions and propellant characteristics required to find the best design may involve a compromise with missile aerodynamics, mass distribution or the dimensions of a warhead. Thackwell has listed the relationships between a number of variables which must be kept in mind by the powerplant designer:

- **Total impulse** varies as the cube of motor diameter for a given length/diameter ratio and port area. A 25% increase of diameter and a corresponding increase in length doubles total impulse.
- **There is** one length-diameter ratio for each propellant that will give a maximum mass ratio for each pressure and payload.
- **Propellant weight** varies parabolically with length/diameter while empty weight varies almost linearly so there is one value of length/diameter beyond which propellant weight no longer rises faster than empty weight.
- **Optimum length**/diameter is independent of motor diameter for a given payload density since both propellant weight and motor empty weight are proportional to the cube of diameter.
- **Best length**/diameter ratio for slow burning propellant is higher than that for fast burning propellant.
- **Larger nozzle** throat is needed if length is increased without changing diameter because burning area and gas flow rate will increase proportionately and wider nozzle throat is needed to prevent higher combustion pressure which would increase burning rate.
- **Port area** must be enough larger than nozzle area to prevent port from acting as nozzle. If this happens, gas stream moves too fast, increasing burning rate at nozzle end of charge and causing dangerously high initial combustion pressure.
- **Maximum propellant** weight is obtained by making port as small as possible.
- **If length**/diameter ratio of the motor is made great enough, nozzle diameter will approach that of the case and since port diameter must be still larger, there will be no propellant at all.
- **Greater propellant** weight is allowed by high combustion pressure because it calls for smaller nozzle and therefore

Army Jupiter Satellite 30 In. Long

Army satellite and final stage rocket, to be launched by a modified version of the Jupiter C multi-stage ballistic missile test vehicle (AW Dec. 9, p. 77), are shown atop a tube about 3 ft. diameter which is presumably the next-to-last stage. This stage is propelled by a cluster of solid fuel rockets. Final stage is powered by a single solid-fuel rocket and is designed to boost the 30-in. long, 6-in. dia. satellite to 18,000 mph. With final stage attached, satellite length is about 80 in. Weight after final stage rocket fuel is consumed should be about 20 lb. First stage is liquid-fuel rocket engine used in Army's Redstone 200-mi. range ballistic missile. Lines on nose cone appear to be paint, not corrugations. At right, Dr. William H. Pickering, Director of the Jet Propulsion Laboratory, California Institute of Technology, which is assembling missile, shows satellite casing and nose cone. The launching of the Army satellite, designed to measure cosmic ray activity, temperature and meteoric impacts, is expected to take place before April.

for jet engines and aircraft applications

Edgewater rings

Edgewater Rings meet the most exacting specifications of the engine and aircraft industries. The accuracy with which they are formed reduces the amount of machining or other finishing required—an important consideration especially when the more expensive materials are used.

Write for brochures giving data on Edgewater Rings.

Edgewater Steel Company
P. O. Box 478 • Pittsburgh 30, Penna.

a smaller port and more propellant.

• **Propellant specific** impulse is somewhat higher at high combustion pressures because these improve the efficacy of the nozzle.

• **Maximum speed** and range for small payload missile can be attained only by using low pressures and intermediate length/diameter ratios because motor is such a large part of total empty weight that a weight saving here can more than offset gain in propellant weight from high pressure and large length/diameter ratio.

• **Opposite is true** for heavy payload missile because motor weight saving effect on mass ratio is less significant than advantages of maximum specific impulse and propellant weight obtained from high pressure and length/diameter ratio.

• **Slow burning** propellant offers greater propellant weight because a much smaller nozzle is needed for a given combustion pressure, so a much smaller port may be used.

• **Burning time** is greatest with slow burning propellant at low pressure (low burning rate) and low length/diameter ratio (long radial burning distance from port to wall).

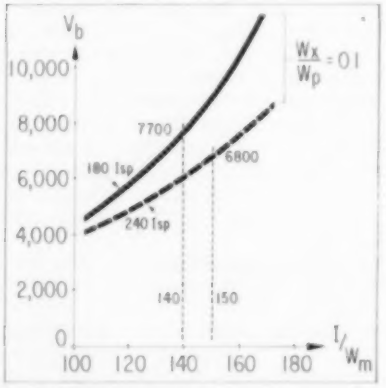
• **Weight of motor** case varies as the cube of diameter for a given length/diameter ratio and wall strength.

• **Empty weight** can be cut by reducing combustion pressure (wall strength requirement).

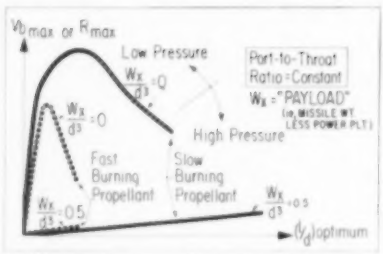
• **Empty weight** can also be reduced to some extent by lowering length-diameter ratio.

• **Percentage** reduction in empty weight from reduced pressure or lower length/diameter ratio is progressively greater as payload becomes smaller because the motor case becomes a larger portion of total empty weight.

• **Higher maximum** velocity and range is given by slow burning propellant regardless of diameter, length and pay-



BURNOUT speed against total impulse/weight ratio for two rockets with equal total impulse and payload shows that heavier rocket with lower specific impulse may outperform lighter rocket.



SLOW burning propellant gives better maximum speed and range regardless of diameter, length and payload because small nozzle needed to maintain a given combustion pressure permits greater weight of propellant in motor case.

load because of the greater weight of propellant which can be carried. This means that it is extremely important to specify a small enough diameter or a long enough burning time to permit use of slow burning propellant.

• **Performance penalty** incurred by non-optimum length/diameter and pressure is less for slow burning propellant.

Small Staff

While it is one of the better known manufacturers in the field, Grand Central employs only a total of about 440 people because of the relatively low manpower requirement in the building of rocket motors. Of the total, about 140 are engineers and scientists. Ten have doctoral degrees and about 40 have master's degrees.

Solid propellants are relatively inert, but they are handled according to Army Ordnance rules for the handling of explosives. This accounts for the fact that Grand Central's small staff requires 9,000 acres of plant and test area. Incomplete test facilities at nearby Beaumont, Calif., account for 8,000 acres.

Progressively more testing can be expected to be done there because the city of Redlands is expanding around the present plant and the community relations problem of a rocket manufacturer is a difficult one.

Forming Charge

The three most widely used methods of forming a propellant charge are casting, extruding and molding. Grand Central uses all three. Casting is considered the better method because it is easy, safe and consistent, and the propellant bonds itself to the motor case thereby insulating it from heat and preventing gas from flowing between charge and case.

For small rockets, the other methods are competitive.

The company is studying such technical approaches as combustible structure and the solid propellant ramjet, but these must wait for specific applications before full-scale development will be practical from a business standpoint.

NACA Evaluates Four Classes Of Missile Nose Cone Materials

New York—Lightweight metals and semi-metals are the best of four categories of materials tested by the National Advisory Committee for Aeronautics for use in heat sink type ballistic missile nose cones.

Heat sink nose cones completely absorb and store all heat energy transferred to a warhead during very high speed re-entry into the atmosphere. In contrast, other types of warheads would reject their heat through a cooling system, or employ a combination of the cooling system and heat sink.

In general terms, the heat sink problem for an ICBM warhead is to find a light material which can absorb a large quantity of heat very quickly while remaining structurally sound under the re-entry loads. The four classes of materials which the NACA theoretically subjected to these difficult specifications are:

• **Heavy ductile materials** with high thermal conductivity, relatively low melting temperature, and low specific heat. Copper was taken as representative of this group.

• **Refractory type** metals of medium density which retain their strength at high temperatures. Inconel-X was studied as typical of this group.

• **Lightweight metals** of which beryllium is an outstanding example.

• **Semi-metals** of which carbon (graphite) was investigated.

The results of the studies were issued in the NACA report TN 4141 written by Jackson R. Stalder of the Ames Laboratory. The report is a general treatment of the materials problem of high speed re-entry nose cones and does not specifically deal with any of the new classes of alloys, ceramics, etc. and combinations of materials that might be used in warheads.

Copper Performances

From a weight standpoint the heavy, ductile metals such as copper were found to be completely inferior to graphite and beryllium. The surface of a copper nose cone would also have to be protected from oxidation during re-entry.

Refractory metals such as Inconel-X were judged to be completely unsatisfactory because of their low rate of thermal conductivity. The Inconel-X surface would reach its melting point early during the re-entry while the rest of the structure would experience practically no temperature rise and could not function as a heat sink.

Beryllium, the lightweight metal, was considered to offer many advantages when used in a nose cone. It has a high strength to weight ratio at elevated temperatures. It distributes heat well, because it has a high thermal conductivity and a high specific heat (requires a large amount of heat energy to raise the temperature of a unit mass one degree). Use of beryllium would result in a six-fold weight saving compared to a copper nose cone. Beryllium has very good resistance against short time oxidation and probably no protection of its surface would be required.

Ductility Lack

Beryllium suffers from one main disadvantage and that is brittleness. Its lack of ductility makes it very difficult to form in large sections and during re-entry it would be susceptible to spalling (breaking or chipping of the surface due to heat and/or mechanical loads).

Graphite, the semi-metal, is superior to beryllium as far as weight is concerned and a nose cone of this material would weigh only 1/24 as much as one of copper, if each material was allowed to reach a surface temperature of 75% of the melting temperature. Troubles arise from the use of graphite because of its low strength and high surface temperature gradiants which are conducive to spalling. A graphite surface probably would have to be protected from oxidation also. Developing high temperature anti-oxidation coatings which allow complete advantage to be taken of materials with high melting temperatures, such as graphite, is considered very difficult.

Australia to Set Up IRBM Launch Site

Melbourne—New launching site for intermediate ballistic missiles will be constructed in Australia during 1958. Preliminary estimates involve the amount of $12 million.

Extended site will test missiles with a range in the vicinity of 2,000 mi. It will be situated at Lake Hart, a dry salt lake about 30 mi. west of Woomera Village in South Australia. Australian plans provide also for the extension of instrumentation at the range and the extension of the range over the Indian Ocean toward Christmas Island.

Official Australian circles are still uncertain as to whether U. S. missiles are to be tested in Australia. This will depend to a large degree on the report of the U. S. technical mission which was recently in Australia for an inspection of Australian defense installations, plants and facilities.

ON THE WORLD'S LONGEST, MOST EXACTING ROUTES:

The Britannia is flying

In February, BOAC entered the Bristol Britannia into passenger service on the London-Johannesburg route. Since then the number of services has steadily increased, and today BOAC's fleet of fifteen Britannia 102's are averaging 112 hours revenue flying daily on seven of the world's longest and most exacting air routes.

Routine efficiency—a million miles a month

ROUTE	ROUND-TRIP MILEAGE	WEEKLY FLIGHTS
LONDON to SYDNEY	23,602 miles	3
LONDON to HONG KONG	19,613 miles	2
LONDON to TOKYO	19,610 miles	3
LONDON to SINGAPORE	15,988 miles	1
LONDON to JOHANNESBURG	12,476 miles	3
LONDON to COLOMBO	10,404 miles	1
LONDON to ADEN	8,092 miles	1

BOAC Britannias are now achieving a fleet average per aircraft of over 7½ hours revenue flying a day, seven days a week—an annual utilization rate of 2,750 hours.

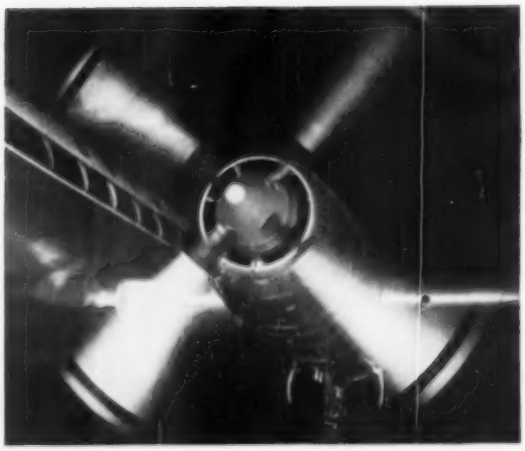
For a new aeroplane to have achieved this during its first year of service is quite an exceptional record—already in the upper bracket of world airline utilization—and one which reflects high credit on the operator.

Worldwide demand for Britannia versatility—dependability

Britannia 300's and 310's are entering service with BOAC, El Al Israel Airlines and Aeronaves de Mexico. They have also been ordered by Canadian Pacific, Cubana de Aviacion, Hunting Clan Air Transport and Northeast Airlines. Britannia 250's are on order for the Royal Air Force, and the British Ministry of Supply.

a million miles a month

BRITANNIA 310 LONG-RANGE AIRLINER



The Bristol Proteus jet-prop engines of the Britannia are the most powerful in airline operation anywhere in the world. During the first 7½ months of scheduled service their permissible running time between overhauls was increased from 500 to 1,050 hours—the fastest that any engine has ever been approved for such a life after going into service.

BRISTOL

Britannia

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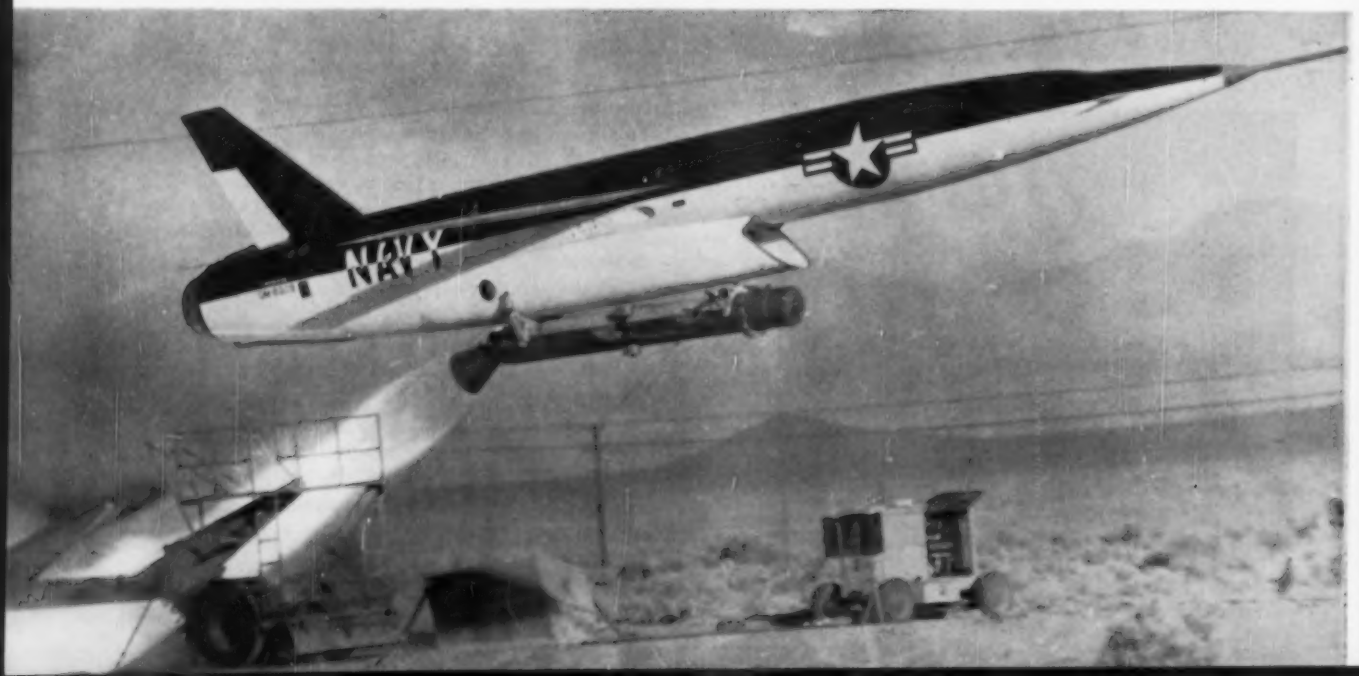
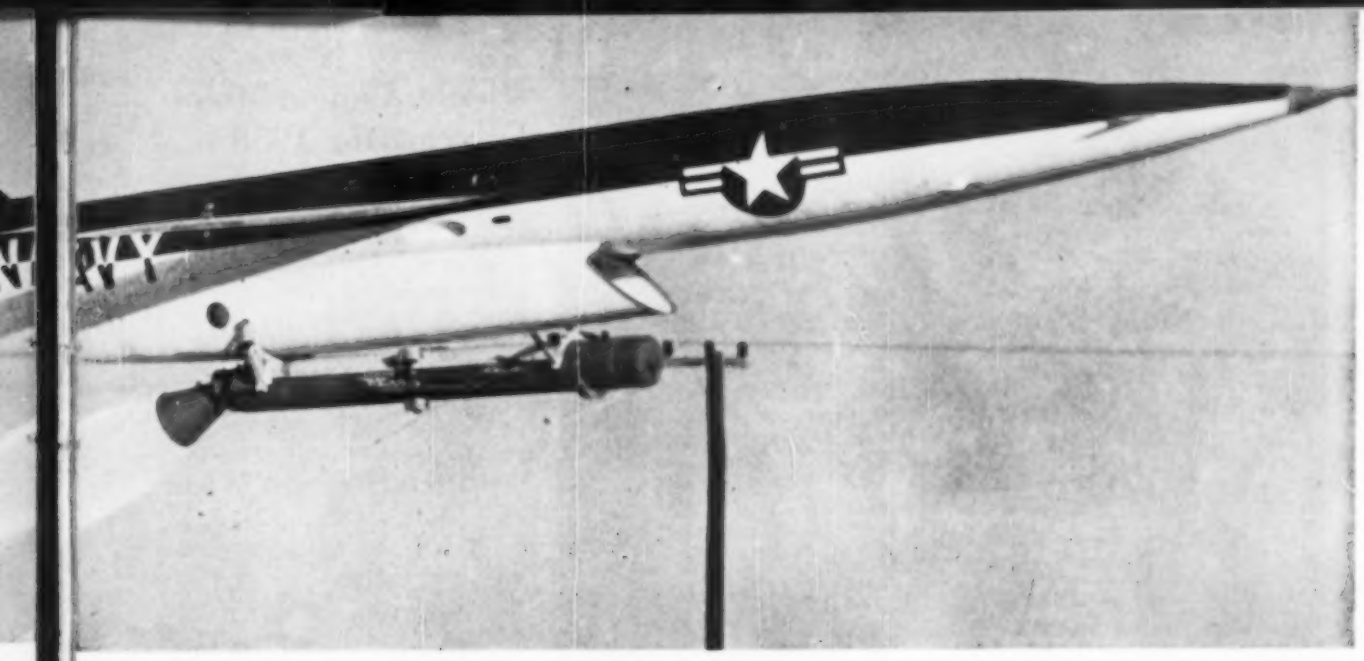
400 Park Avenue, New York 22, N. Y.

Solid Propellant

Photographic sequence shows training and test model of Navy Chance Vought Regulus II aerodynamic missile being launched at public demonstration at Edwards AFB, Calif. (AW Dec. 16, p. 31). During 29-min. flight, Regulus II rose 50,000 ft., attained 1,200 mph. Eleven-ton, 57-ft. long missile is lifted off launcher by Aerojet-General solid propellant booster rocket generating 115,000 lb. thrust. Burnout time of 20 ft. long, 20 in. dia., 4,500 lb. booster is 4 sec. Nozzle is canted 17 deg. below missile centerline to direct thrust line through missile's center of gravity. Boundary layer bleed is visible under extremely thin wing (top photo).

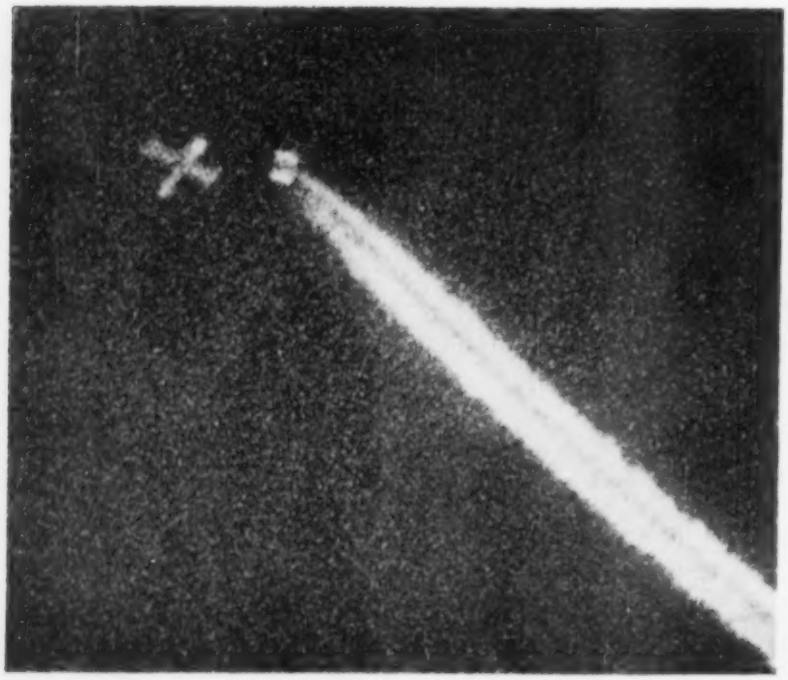




Booster Rocket Gives Regulus II 115,000 lb. Push

British Thunderbird Strikes Jindivik In Test Firing

English Electric Thunderbird antiaircraft missile launched at Woomera range in Australia (above) is photographed just before striking Jindivik target drone. Test, made without warhead, simulated evasive maneuvers by target. When the missile was recovered on ground, part of Jindivik engine was found imbedded in its nose. Thunderbird has four solid propellant rockets wrapped around solid propellant sustainer (AW Sept. 9. p. 27)



Missile Around Moon Forecast for 1958

Los Angeles—Space travel accomplishments for U. S. within the next 10 years were predicted last week by Dr. John L. Barnes, president of Systems Corp. of America, at a local meeting of the American Rocket Society here. Based on the premise that sufficient funds would be made available, Barnes forecast these events would occur by the end of the following years:

• **1958.** Ballistic projectile would be fired around Moon return to Earth's atmosphere, where it would burn up. Instrument payload would be about 2 lb. Balloon would be used to carry the missile initially to about 100,000 ft. (as in Project Farside) where first stage of missile's solid propellant rocket would be fired. Instead of balloon, liquid propellant rocket might be employed as an initial stage for firing from surface, coupled with solid propellant stages. No guidance would be involved, hence ballistic trajectory would have to be very accurate.

Another possibility of the same general scheme would involve instrumentation and a small animal for total payload of 10 lb.

• **1959.** Instrumentation totaling 25 lb. would be landed on the Moon.

• **1960.** As a variance of the 1959 scheme, the projectile would carry instruments and animal for a total of 25 lb., would have guidance.

• **1961.** Guided and manned vehicle would travel to above the Earth's atmosphere and return. Chemical liquid or solid propellant rocket stages would be involved.

• **1964.** Projectile would be fired around Venus or Mars and return to Earth's atmosphere, where it would burn up. Instrumentation would total about 50 lb. Propulsion would be nuclear fission rocket. Trajectory would be ballistic.

• **1965.** Earth satellite would be put up, then landed on Earth with guided re-entry. Instrumentation and animal payload would total about 500 lb. Propulsion would be with chemical, liquid or solid propellant stages.

• **1967.** Vehicle would be put into an orbit around the Moon, then return to earth with guided re-entry for landing. Vehicle would carry both instruments and animal. Propulsion would be chemical rocket initially, coupled with nuclear fission rocket for second stage.

For same year, similar scheme is predicted using manned vehicle.

Following this 10 year period, Barnes said the following might take place:

• **1968.** Vehicle would be landed on the Moon and returned to Earth. Moon landing and takeoff would be

controlled by pilot in chase space vehicle which orbits moon. Payload would consist of instrumentation and animal. Vehicle would have guidance, and propulsion would comprise chemical and nuclear fission staged-rocket.

• 1971. Manned vehicle would be landed on moon and returned to earth. Propulsion for this guided vehicle also would be with chemical and nuclear fission staged-rocket.

• 1975. Manned vehicle would be landed on Venus or Mars, then returned to earth. Propulsion would be by nuclear fusion rocket.

New Polaris Facility Planned by Lockheed

Sunnyvale, Calif.—Polaris missile development facility will be built for Navy by Lockheed Missile Systems Division at its plant here.

New center will cost $3 million and house test, engineering, planning, and Navy and Lockheed administrative functions in a 153,000 sq. ft. building.

Navy recently tripled funding for the Polaris fleet ballistic missile by awarding Lockheed a $62.1 million development contract (AW Oct. 28, p. 30). Rear Adm. William F. Raborn, director of the Special Projects Office of the Bureau of Ordnance, referred to the new facility as a "command post."

Lockheed is deeding 13 acres of land adjacent to its present buildings to Navy so the new building will be a self-contained Navy owned facility on Navy ground. Architect-engineering is being done by the Division's Plant Engineering Department and J. H. Pomeroy Co., Inc. of Los Angeles.

Wells to Head IAS

Edward C. Wells, vice president-engineering of Boeing Airplane Co., has been elected 1958 president of the Institute of Aeronautical Sciences. He succeeds Mundy I. Peale.

British Reduce Funds For Rocket Test Site

London—Britain's Hebrides Island rocket facilities off Western Scotland will fire surface-to-surface missiles only, Defense Minister Duncan Sandys told the House of Commons when announcing a $42 million cut in the $56 million rocket range project.

Air-to-air and surface-to-air missiles that would have been fired in the Hebrides under original plans will be fired instead at the Ministry of Supply rocket establishment at Aberporth and the Army gunnery range at Tycroes, Anglesey.

Sandy said he hopes the Hebrides range will come into use next year.

Construction Begins Of Sites for Bomarc

Boeing Bomarc, area defense interceptor missiles, will be operational by 1960. First Bomarc installation will be located near Dow Air Force Base, Bangor, Me., and its construction will begin this month. Other Bomarc bases in the East are planned for Massachusetts, New York and New Jersey.

These sites will be integrated into the Eastern air defense system as soon as possible and will greatly increase its effectiveness. Nike Ajax and Hercules missiles which will be the missile backbone of air defense until 1960 have less than 30% of the Bomarc's range.

Cost of the Bomarc base at Bangor will be $12 million and the installation will be much more extensive than a Nike site. However, Bomarcs from Maine and Cape Cod will be able to defend all of New England.

Testing of the Bomarc is still under way at Patrick Air Force Base, Fla. Recent firings have been reported by the Defense Department as being completely successful. Target drones have been destroyed by collision rather than using explosive warheads.

Marquardt Firms Up Plans for Expansion

Marquardt Aircraft Co., Van Nuys, Calif., has programmed second round of expansion of its Ogden, Utah, ramjet engine facility, according to Roy E. Marquardt, president.

About 110,000 additional square feet will be added to the plant at a cost of between $1.5 to $2 million. This would double present footage. Design is under way and contracts will be let by mid-1958.

The ramjet goes primarily to the Boeing Bomarc guided missile.

Marquardt said the expansion ultimately would require the company to engage in some new equity financing, and that in part the program might rest with "Air Force orders." He added that the Van Nuys plant was becoming a primary research and development center for Marquardt with manufacturing being stressed at Ogden.

Japanese IGY Rockets Fail in Research Role

Tokyo—Japanese rockets used so far in the International Geophysical Year program have proved defective and incapable of playing a role in the observation of cosmic rays, according to Prof. Hideo Itokawa of Tokyo University, head of a Japanese rocket research team.

The latest Kappa-4 rockets launched on the Japan Sea coast in Akita Prefecture did not gain the altitude they were designed to achieve. Investigation revealed that the rocket bodies were unbalanced.

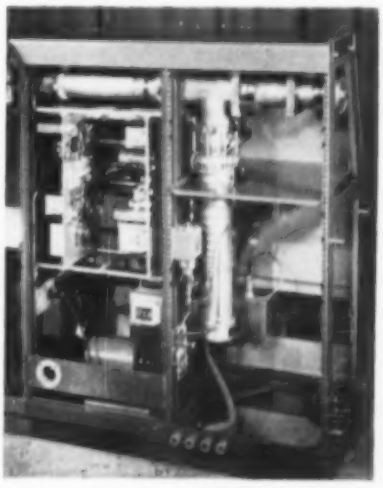
Instrument Analyzes Rocket's Combustion

Device to analyze rocket combustion within a ten-thousandth of a second time interval has been announced by Bendix Aviation Corp., Detroit, Mich.

The "time-of-flight mass spectrometer" electronically analyzes the sequence of chemical reactions. The instrument operates on the principle of identifying vaporized gases, liquids and solids by revealing their respective molecular masses.

Possibilities for use of the new research tool include analyzing fuel combustion in turbojet and ramjet engines and for study of materials with very high temperature stability—including missile nose cones, ceramics and glass.

Heart of the instrument is a four-



BERYLLIUM FROM BRUSH

COMMERCIALLY AVAILABLE

ADVANCED DESIGNS DEMAND THE UNIQUE PROPERTIES OF THIS LIGHT, STRONG METAL

✻ BRUSH has added a new, privately financed plant for tonnage production of Beryllium metal, eliminating availability problems and reducing product costs.

Brush Beryllium

BERYLLIUM METAL Be QMV BRAND

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foot ion gun. Ions (molecules which are electrically charged because some of their electrons have been knocked off) of the elements being analyzed are pulsed like radar signals from one end of the tube to the other. Their speed is measured electronically and appears as a wave pattern, representing the spectrum, on an oscilloscope.

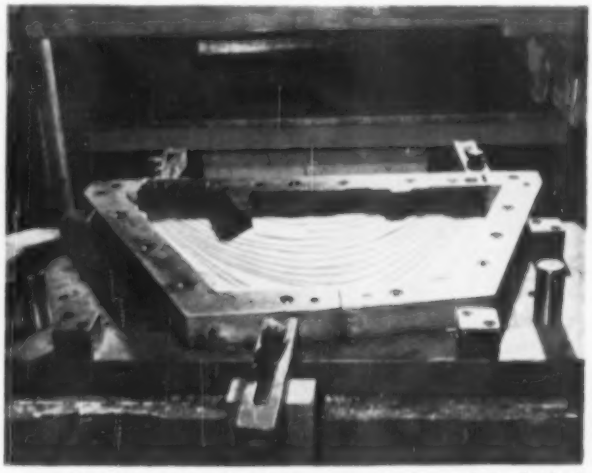
This use of radar techniques to pulse the signal up to 10,000 times/sec. is the key to the new spectrometer's high speed, said Dr. Albert C. Hall, general manager of the Research Laboratories Division, Bendix, where the spectrometer was developed.

Bendix believes that with this device it will be possible to isolate and identify the intermediate molecules responsible for corrosive deposits in nuclear reactors, jets, diesels and piston engines. In this respect the device ought to prove helpful in understanding why some of the new high energy fuels foul engines so quickly.

Hall said that a smaller 37-lb. version of the normally 800 lb. spectrometer could be installed in jet aircraft to discover why jet engines flame out or stall when the plane flies into the exhaust of its own rockets. Other miniature mass spectrometers are expected to be used in missiles and satellites to sample the degree of emptiness of space and reveal more of its exact composition.

Commercial models of the spectrometer will be built in the Cincinnati Division of Bendix. The first unit off the line is slated to go to the U. S. Bureau of Standards. Early models built in the research laboratories are now in use by several major companies, universities and government agencies, Bendix said.

It is expected that models of the mass spectrometer will be priced from $15,000 to $25,000.



FIBERGLAS pieces for Regulus II nose trimmer are laid out on screens to dry (left) before being heated in presses. Contours of the finished trimmer are achieved by varying the shapes of the pieces making up sandwich. At right, half of pieces are assembled in press form.

Regulus II Has Fiberglas Trimmer Vanes

Dallas—Fiberglas nose control trimmers have been developed by Chance Vought Aircraft for Regulus II to give the missile better landing characteristics without interfering with radio transmissions which control Regulus II in flight.

Trimmer vanes are mounted on each side of the missile's nose to control it on takeoff and landing. Vanes keep the nose of Regulus II from dropping too fast on landing and allow the missile to be landed 30 mph. slower than it could land without the vanes.

A prime requirement in designing the trimmers was that they not interfere with radio transmissions which control Regulus II in flight. This requirement ruled out metal vanes, and Chance Vought decided to use Fiberglas.

Machined Fiberglas could not be used because exposed edges of the cloth would split into layers when the missile hit its Mach 2 speed range, so Chance Vought settled on laminated Fiberglas trimmers bonded under high temperature and pressure.

Trimmers have knife edges on three sides and taper to an inch thickness on the side next to the missile. Inboard side is recessed to take steel forgings and magnetic clamps which link the vanes and control them in flight.

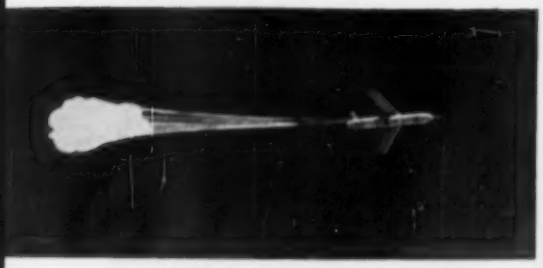
Laminated vanes have 150 layers at the thickest point and taper to six layers at the edges. Various-sized patterns are cut when the Fiberglas cloth is in the soft stage, then pre-cured to dry out excess solvents and moisture.

Patterns are laid out with the largest on top and bottom, smallest in the middle. Dies are pressed together and heated to 200F to warm the resin and allow some of the gas between layers to vent. After 30 min., temperature is raised to 320F and 150 tons of pressure is applied for two and a half hours. After cooling under pressure, vanes are inspected, then put in an oven for four hours at 180 deg. and for an additional period at 350 deg. for post-curing.

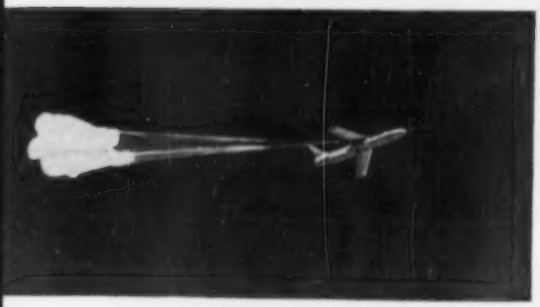
TRIMMER vanes, mounted on each side of Regulus II nose to control it on takeoff and landing, have thin edges.

Parachute Brakes Matador

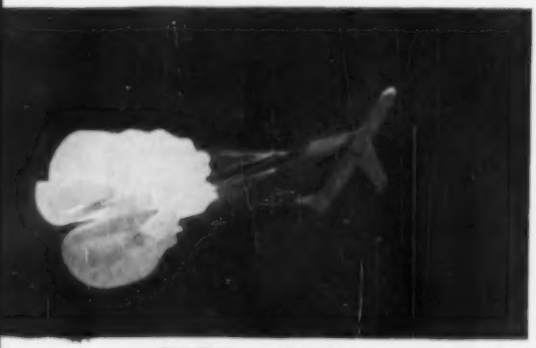
EXTRACTION chute begins to pull cargo chutes from Matador.



NOSE starts up as cargo chutes fill.

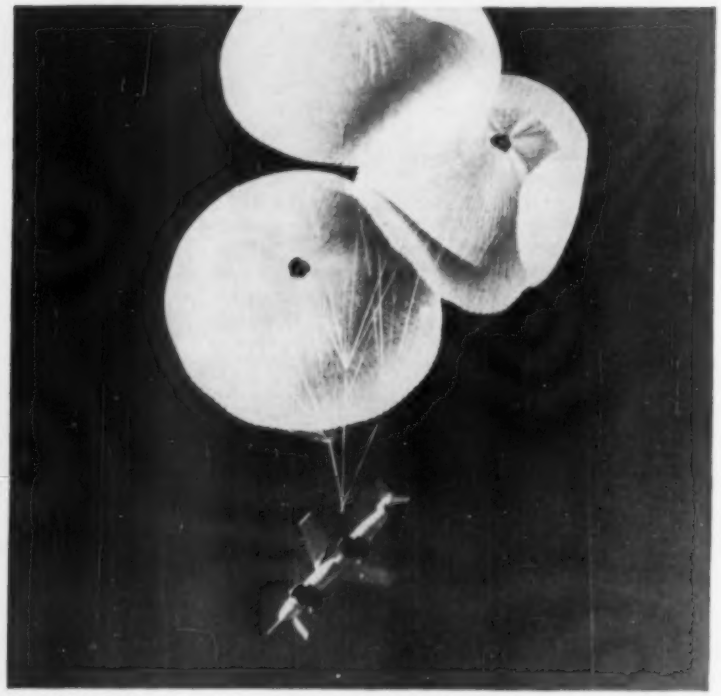


BRAKING continues, nose goes higher.

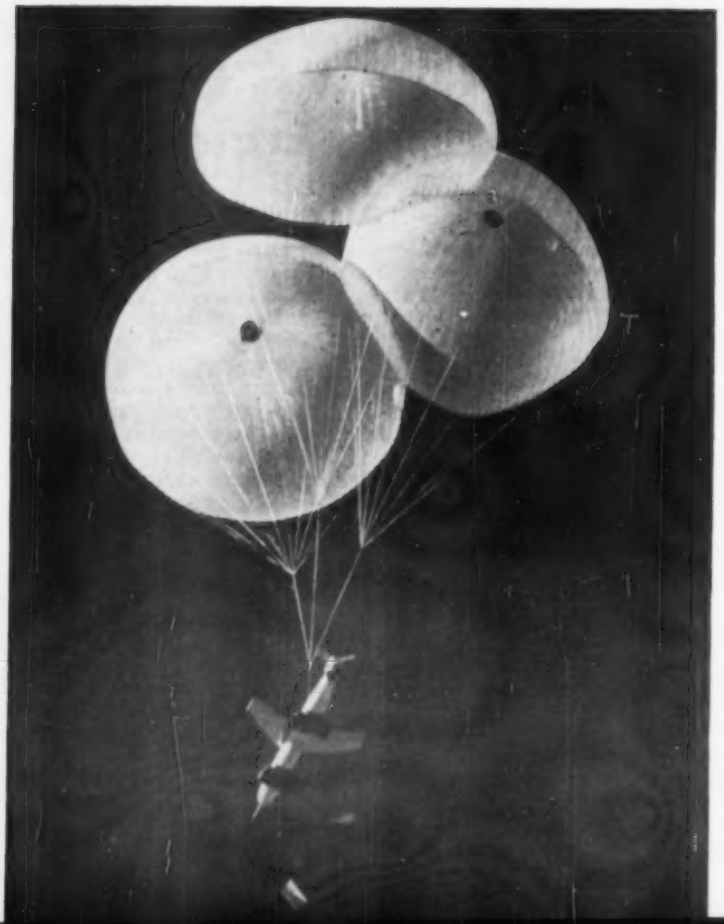


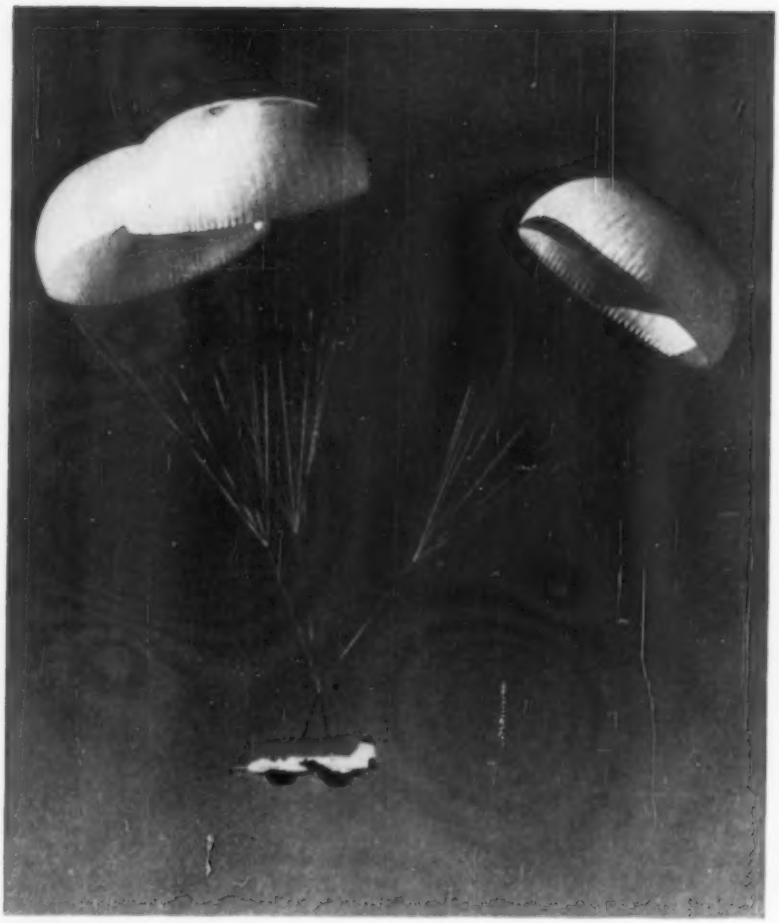
CHUTES are almost full, nose at highest point.

MATADOR (below) now swings beneath the three chutes.



LANDING BAG covers pop off missile's underside and fall away, landing bags inflate to cushion touchdown.





FLOATING to ground, Matador is recovered intact. Pictured sequence began at 2,300 ft. after a drag parachute had slowed the missile at high altitude, power was cut back to 60%, and it was guided down to the lower height.

Free Radical Power Must Await Research

Industry is pushing into free radical propulsion work without stopping to wrest out the basic nature of this phenomenon, scientists associated with free radical research in the National Bureau of Standards, Washington, D. C., and the Air Force's Wright Air Development Center, have told AVIATION WEEK.

As has happened on new concepts before, some segments of industry have tooled and staffed to conquer a problem on too practical a level when the basic research is still unavailable.

One scientist said there would be a long, confused pause before university and governmental agency basic research caught up, or industry reorganized itself to provide its own basic research program.

The conflict of opinion on the immediacy of frozen free radical fuel propulsion illustrates one phase of a fundamental difference between scientists in non-profit research organizations and industry.

This difference has become more meaningful since Russia launched Sputnik I and II.

A rocket propulsion expert of a large eastern university told AVIATION WEEK that the recent waves of enthusiasm for frozen free radical rocket fuel are the result of a tendency of some engineers to become overly optimistic about any new source of energy which scientists have proved to exist in laboratories, and to feel that, given enough funding and a big enough applications research project in an industrial setting, they can put the scientists' discoveries quickly to work.

Mere size and money will not overcome profound shortages of basic knowledge, which have historically only been produced efficiently in scientifically sympathetic surroundings rather than under industrial pressure, these scientists assert.

Free radicals are electron-deficient atoms which, when they combine with a stable substance, emit sizable amounts of energy.

Hydrogen radicals are usually preferred for propulsion because of their low molecular weight.

The trouble with free radicals is that they have to be kept frozen and separated up to the point at which they are to be allowed to recombine and produce energy.

In his analysis of their potential, the university propulsion expert said he first eliminated liquid helium for the refrigerating medium as both too expensive and too cold for practical propulsion systems. Instead, he considered liquid nitrogen, which can be kept liquid at

Rugged Design—Proven by Official

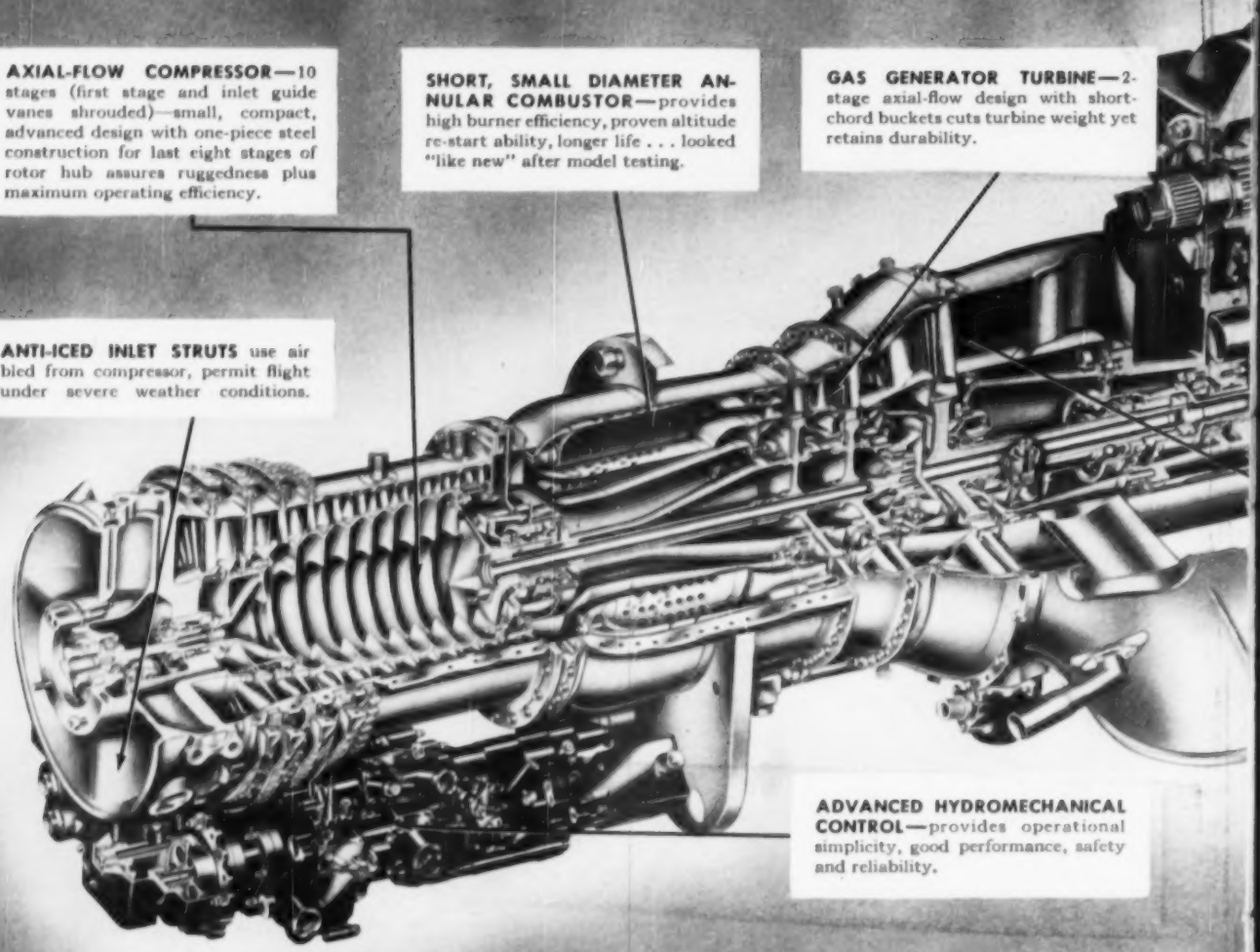
WHY T58 IS BEST

AXIAL-FLOW COMPRESSOR—10 stages (first stage and inlet guide vanes shrouded)—small, compact, advanced design with one-piece steel construction for last eight stages of rotor hub assures ruggedness plus maximum operating efficiency.

SHORT, SMALL DIAMETER ANNULAR COMBUSTOR—provides high burner efficiency, proven altitude re-start ability, longer life . . . looked "like new" after model testing.

GAS GENERATOR TURBINE—2-stage axial-flow design with short-chord buckets cuts turbine weight yet retains durability.

ANTI-ICED INLET STRUTS use air bled from compressor, permit flight under severe weather conditions.

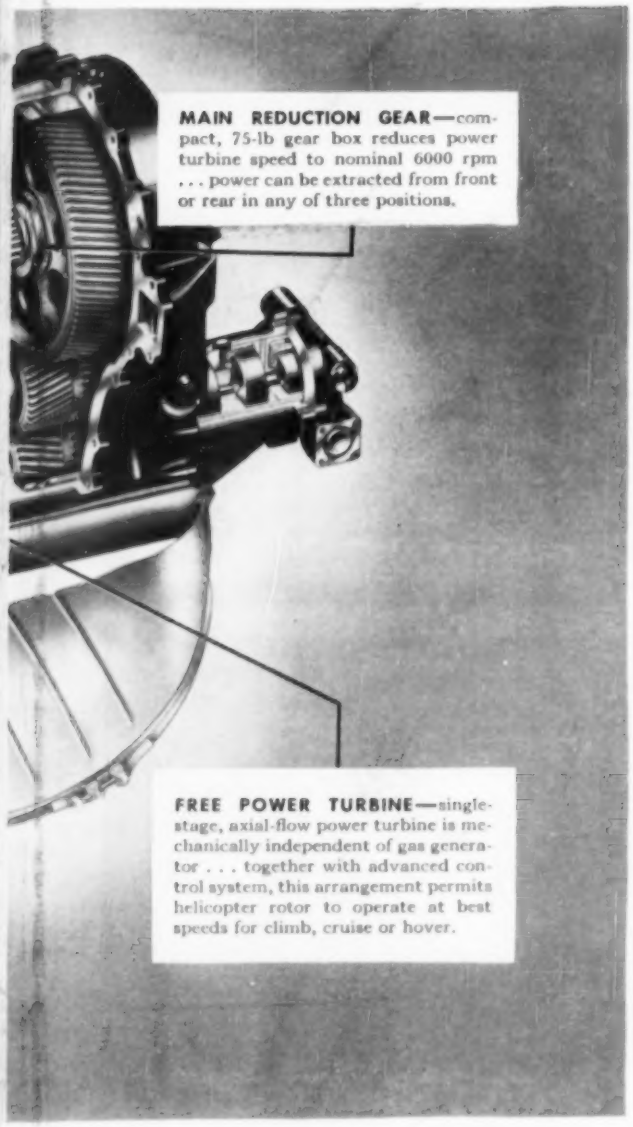


ADVANCED HYDROMECHANICAL CONTROL—provides operational simplicity, good performance, safety and reliability.

T58 FLIGHT TEST PROGRAM began in January 1957 in Sikorsky HSS-1 (left), was recently extended to Vertol H-21D (center) and will include the Kaman HU2K-1 (right). Comprehensive flight, rotor and cell tests have already proven the engine's performance, reliability, control stability and power-splitting ability.

150-Hour Test—is one more reason . . .

FOR HELICOPTERS


MAIN REDUCTION GEAR—compact, 75-lb gear box reduces power turbine speed to nominal 6000 rpm . . . power can be extracted from front or rear in any of three positions.
FREE POWER TURBINE—single-stage, axial-flow power turbine is mechanically independent of gas generator . . . together with advanced control system, this arrangement permits helicopter rotor to operate at best speeds for climb, cruise or hover.

Exacting Endurance Test Program Proves Outstanding Durability of General Electric's T58

Official 150-hour Model Test results accepted by the Navy's Bureau of Aeronautics prove that General Electric's T58 engine offers helicopters not only extraordinary performance and operating advantages, but also outstanding durability and ruggedness.

DURABILITY OF THE T58 engine design was thoroughly proved during the 150 hours of rigorous testing, more severe than actual flight conditions. T58 official test results ***exceeded*** all performance guarantees. For example, the T58 produced 1065 military hp, compared to the guaranteed 1024 military horsepower. Normal rated SHP, guaranteed at 875 hp, was increased to 920 hp. Both military and normal rated SFC guarantees were bettered.

RUGGEDNESS OF THE T58 engine design was proved by its exceptional performance under the severe accelerating and decelerating, stops and starts, loads and overloads. Official test results show:

- All required 75 starts exceeded specification guarantees. Typical acceleration time to idle speed bettered guarantee by over 40%.
- All engine throttle burst times were well within guarantee limits. Acceleration times from idle to 100% power were four times better than guarantee.

ADVANCED AERODYNAMIC DESIGN. Engine cut away at left shows the advanced design features that make possible the T58's exceptional performance and ruggedness . . . features that truly promise new levels of military and commercial usefulness for helicopters.

For more information about the T58: call your local G-E Aviation and Defense Industries Sales Office, or write General Electric Company, Section 233-10, Schenectady 5, N. Y.

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GENERAL ELECTRIC

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NAS 2803	10-32
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NAS 2805	5/16-24
NAS 2806	⅜-24
NAS 2807	7/16-20
NAS 2808	½-20
NAS 2809	9/16-18
NAS 2810	⅝-18
	¼-16
	⅞-14
	1-12

2. Adaptable to all heads (with weight savings, too)

The flat fillister and button head configurations shown here are two examples of additional head styles available in a full range of sizes. The small heads also offer important weight savings . . . for example, the ¼-28 flat fillister head with a head height of .150 and a .375 diameter will accept the TORQ-SET design and deliver driving torques far in excess of requirements.

What's more, you get in TORQ-SET a single design in wrenching and tooling for *all* aircraft applications from the smallest electronic component to the most critical structural location.

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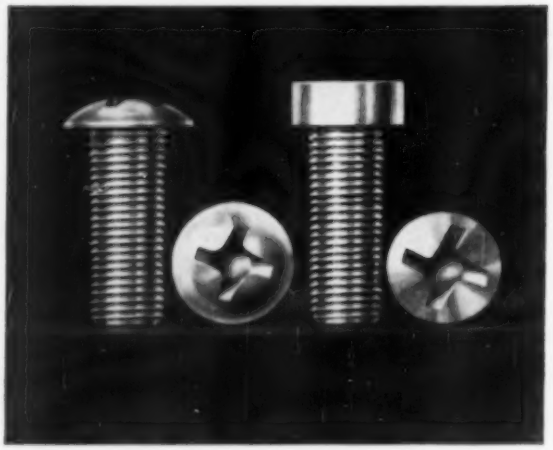

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higher temperatures than liquid helium. He still found that since one would have to carry along a sufficient amount of the inert substance to keep the free hydrogen radicals separated, and this would be involved in the combustion and rocket exhaust process, the overall impulse would not be impressive.

He stressed that even this low performance system was beyond the state of the art, and therefore concluded that a high performance system which would use only pure free hydrogen radical fuel without any inert to give the theoretical 1,000 sec. specific impulses would be next to impossible at this time.

The pessimistic conclusions of this scientist agree with opinions which have been voiced for some time by Dr. Broida of the National Bureau of Standards.

Dr. Broida believes that the present enthusiasm is premature, if warranted at all. Broida's opinions have been supplemented from the propulsion viewpoint by three workers at the aeronautical research laboratory of USAF's Wright Air Development Center, Dayton, Ohio, in their WADC technical note, "Free Radicals as Fuel."

Reasons why Broida forecasts that, barring an unforeseen development, free radical propulsion is a long way off are:

• **Equipment size and weight.** Only present way to handle free radicals is in solid rocket form where solid rocket fuel is kept solid, and radical state maintained, by such weight and complexity of surrounding envelopes of liquid helium and nitrogen that the five times gain in specific impulse which has been calculated on paper will be offset by equipment weight. One in effect will have all the complexities of a liquid rocket system, with the clumsiness of a solid rocket.

• **High chamber** temperatures necessary to realize the full five-times benefits in free radical specific impulse.

As against the 5,000F chamber temperatures customary in current rocket engines, free radical systems ought to have up to 8,500F temperatures to realize all possible specific impulse which they need to offset their complex installations.

The operational problems in using frozen free radical "monopropellant" would be many:

• **Storage** and transportation of a very explosive medium.

• **Fueling** the rocket vehicle.

• **Control** and release of energy in the vehicle.

Broida's comments referred to hydrogen atom radicals in a molecular hydrogen solid.

Even if these problems were solved, Broida said, as yet no means for mass-producing free radicals has been found. Broida recalled the dynamic industry official who, when told that researchers were producing ounces (of rather low percent of free radical in the inert), demanded carloads.

Present method used by Bureau of Standards for producing free radicals for experimentation consists of putting the parent gas through an electronic resonance chamber and then trapping the resulting free radicals by quickly freezing at near absolute zero temperatures.

Motion pictures of Broida experiments show how the free nitrogen radicals trapped at the bottom of his laboratory freezing chamber had a greenish hue.

Broida described the solid which contained the free radicals as looking like loosely packed snow.

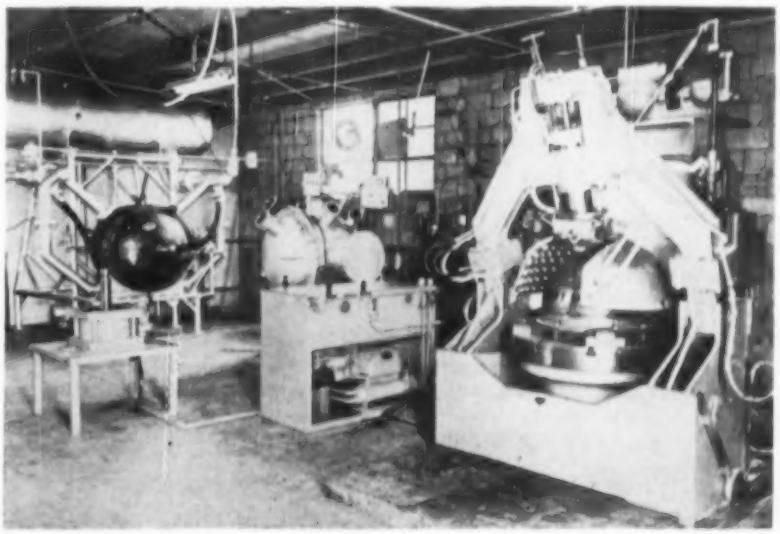
As the temperature was raised to 28K, blue flashes representing flame fronts during free radical recombination were seen to move across the solid. These Broida cautiously interpreted as the free radicals becoming un-frozen and recombining, releasing the energy seen as the blue light.

For propulsion systems, hydrogen rather than nitrogen would be used, as nitrogen's molecular weight is too high, Broida said.

Though the scientists who have been referred to here were pessimistic about immediate propulsion uses for free radicals, none of them wished to be interpreted as saying the basic research in this field should either be slowed down or stopped. On the contrary, they unanimously believed that basic, but general, research which was not overly slanted toward any end product should be accelerated in this as in other fields. Since the exploration of low temperature regions in itself is just beginning, no one can predict what will be learned.

Broida believes that the possible industrial applications like the manufacture of ozone are much more immediately promising than rocket propulsion.

What is most important for research, all of the scientists unanimously agreed, is that it be built around well chosen individuals rather than equipment. Broida said that the equipment needed to get started costs in the neighborhood of $50,000.



Missile Tanks Made of Titanium

Titanium Fabricators, Inc., Burbank, Calif., is making missile pressure vessels under contract for Convair Division of General Dynamics Corp., San Diego. Company uses heat-treatable 6A1 4V titanium alloy, working it into the pressure vessels on specially designed equipment. Blanks are heated and hot-spun on a vertical spinning machine to form hemispheres, then arc-welded into spheres. Spinner is completely hydraulic to provide flexibility in feed, speeds and pressures which firm says it has found vital in hot-forming titanium. Contouring tool is held by a special yoke which moves on an axis of the great circle of the hemisphere.

The yoke can also hold a machine tool for final finishing operation and cut-off.

Welding is done semi-automatically in an inert atmosphere in another company-designed machine. Final operation is to heat the pressure vessels, then quench them with water sprays. Picture of Titanium Fabricators equipment shows, left to right, heat treat chamber, weld chamber and vertical spinner with pre-heater and yoke.

SLAB tail of SR.53 has full nose-up deflection. Note that trimmer is fully deflected too, indicating surface trimmer is used as low-speed follower.

EQUIPMENT used during test program on SR.53 at Boscombe Down includes high test peroxide trailer (background) and silencer behind plane to take blast of de Havilland Spectre.

SPECTRE rocket of the Saunders-Roe 53 discharges into a Cullum exhaust silencer. Water spray at inlet silences engine and is discharged as steam at downstream end of silencer.

West German

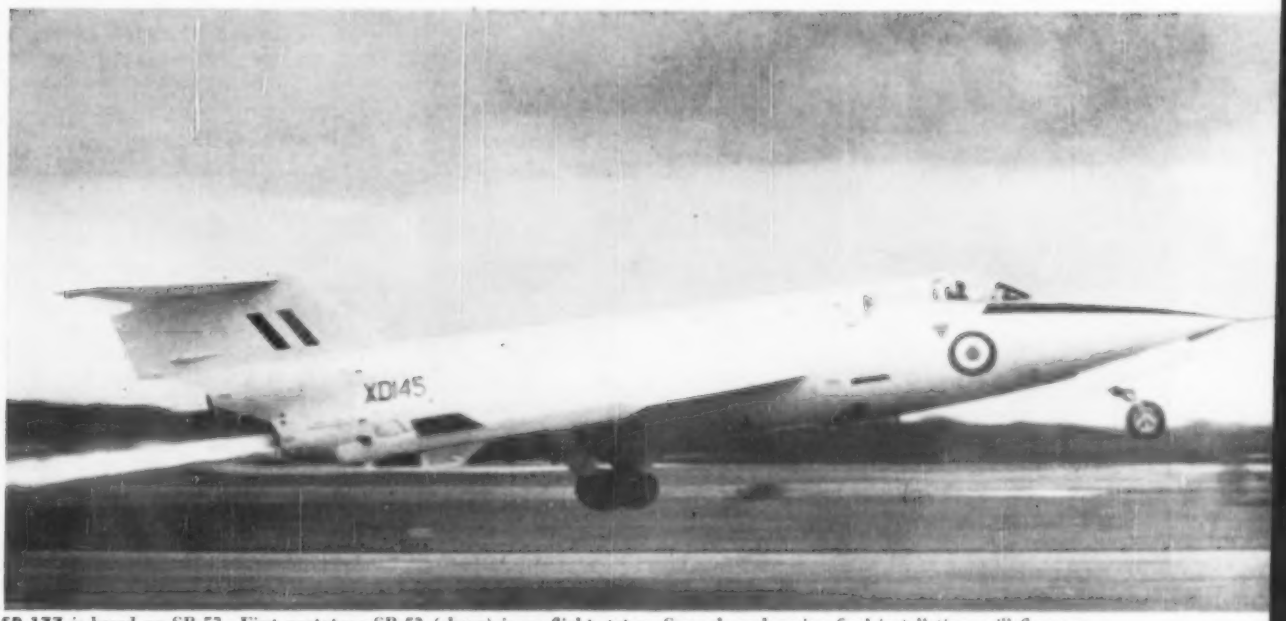
By David A. Anderton

London—Future of the Saunders-Roe 177, one of Britain's most promising airplane designs, now almost certainly depends on an order from West Germany.

An estimated six prototypes are being built at the Saunders-Roe factory on the Isle of Wight, under a Ministry of Supply contract on behalf of the Royal Navy. But most informed observers believe that if the Germans don't buy, the Ministry will terminate the work.

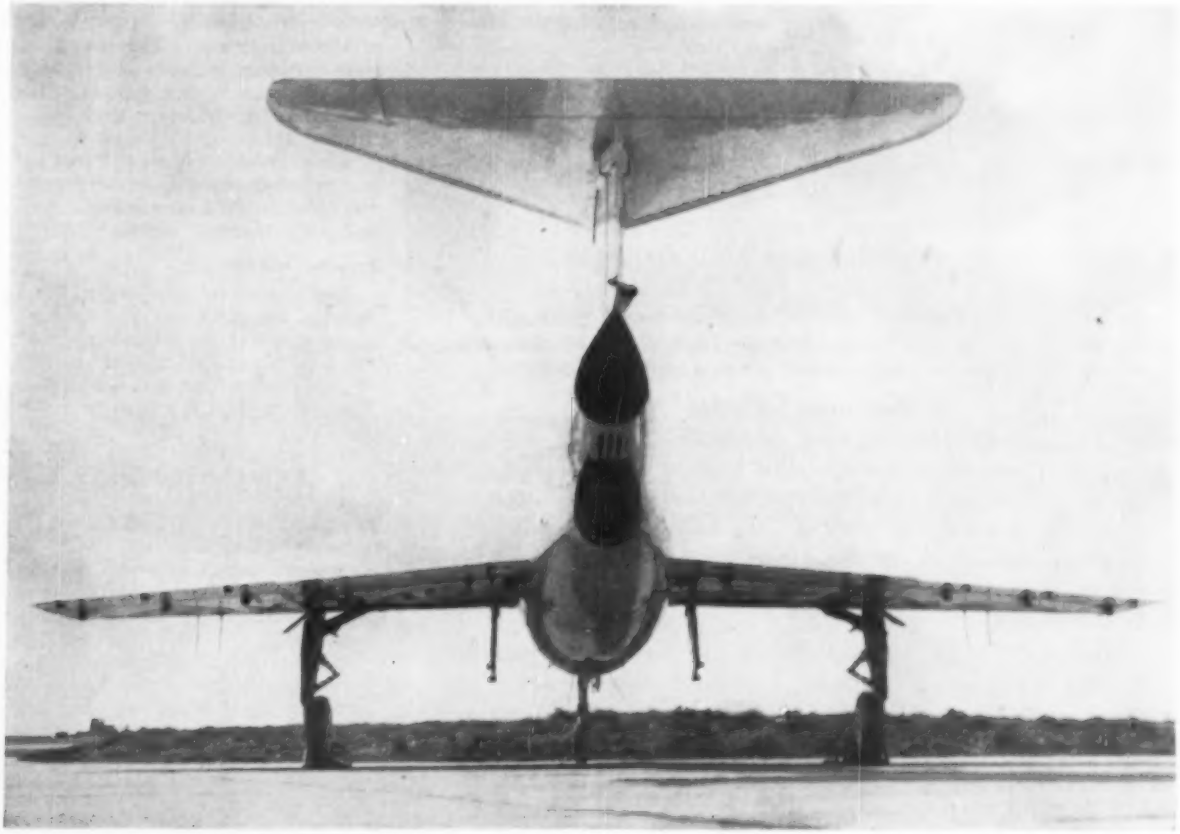
The SR.177 is a mixed-powerplant, all-weather interceptor, based on the SR.53 which was one of the three highlights of this year's Farnborough display (AW Sept. 9, p. 26). Powerplant for the SR.177 will be a de Havilland Gyron Jr. turbojet rated in the 8-10,000 lb. thrust category plus a de Havilland Spectre throttlable rocket rated at about 8,000 lb. maximum thrust (AW Oct. 28, p. 63).

Fuel for the Spectre is the aviation-grade kerosene used also by the turbojet. Oxidizer is high-test peroxide (HTP) of about 85% concentration. Use of peroxide makes it possible to develop a self-contained airplane as far as needs for external power sources go. The decomposition of high-test peroxide, which produces steam and oxygen at about 1,100F, is used as a source of internal power. The decomposition product can drive an auxiliary power



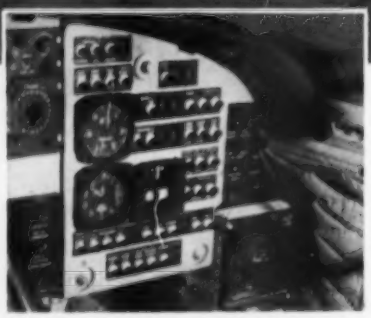
SR.177 is based on SR.53. First prototype SR.53 (above) is on flight status. Second, undergoing final installation, will fly soon.

Orders May Determine SR.177's Future



SR.53 prototype has over-and-under powerplant layout. Note three stripes of temperature-indicating paint under turbojet tailpipe.

The electrical system in this Cessna T-37 Jet Trainer is protected by KLIXON circuit breakers.



Part of the instrument panel in the Cessna T-37 showing KLIXON circuit breakers.

KLIXON Circuit Breakers

Protect Electrical Circuits in Air Force T-37 Trainer

Designed to become a vital link in USAF's all-jet crew training program, Cessna's new twin-jet side-by-side T-37 primary trainer is a fast, compact, easy-to-handle airplane.

In keeping with this design concept is the new KLIXON D6761 push-pull circuit breaker, which includes numerous advantages previously unavailable in a miniature design.

Features include:

New type thermal element with double break wiping contacts, assuring positive snap action circuit opening.

Trip-free action assures that the thermal element is *free* to open an overloaded circuit regardless of the position of the push button.

Simplicity of design — just three moving parts — thermal element, slide, and actuator.

Ratings from 3 to 35 amperes.

The D6761 is another high quality KLIXON circuit breaker — product of 20 years of experience in aircraft circuit protection.

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KLIXON

unit for systems needs as well as a starter unit for the turbojet. De Havilland has designed, developed and presumably installed such auxiliary units in the SR.177 and SR.53.

High Altitude Interceptor

Mission of the SR.177 is high-altitude interception of jet bombers. In this respect it can be thought of as a manned booster for two de Havilland Firestreak infrared homing missiles, carried one at each wingtip.

Performance of the plane is expected to be above the Mach 2 range, with supersonic climbing speeds and maneuverability at altitudes above 90,000 ft. Thrust-weight ratios above one are available at takeoff.

Its short-field performance, high rate of climb and all-weather missile capability make it a strong contender for the Luftwaffe's air defense force. The basic simplicity of the airframe and powerplants, plus the smallness of the plane and the small amount of auxiliary equipment needed, are contributing factors that increase its chances of being adopted by a "freshman" air force.

Slab-sided and thin-winged, the SR.177 is no beauty; but its lines echo the functions of its primary mission. Starting with its ogival radar nose, the fuselage develops into a ventral inlet with a variable wedge for flow control at supersonic speeds. The cockpit has a knife-edge windshield and optically flat side panels; its top line fairs straight aft in the upper deck line of the fuselage.

Below the cockpit on the port side is a refueling probe which will enable the plane to take on additional fuel—but not oxidizer—in flight.

Engine Mountings

The Gyron Jr. is mounted in the belly of the plane and the Spectre i above it, but at the extreme aft end of the fuselage. Speed brakes are fitted at either side of the turbojet tailpiece. The oval fuselage is topped by a T-tail assembly.

Trapezoidal wings of moderate aspect ratio are mounted well aft, and a single Firestreak missile is carried at each wingtip.

Saunders-Roe says the SR.177 will have more operational equipment than the prototype SR.53s shown at Farnborough, including airborne-intercept radar.

None of the SR.177 airframes have been completed; the only clue to the layout of the airplane has come from a model, devoid of markings, but painted in the slate-grey and pale-chartreuse color scheme of the Fleet Air Arm.

There is similarity between the SR.177 and the SR.53 prototypes, but

DE HAVILLAND Firestreak missiles are carried by SR.53 (left). Plane has low fin on T-tail (right); horizontal tail is all-movable.

it is more in the nature of a family resemblance than that of identical twins. Both airplanes were designed to the mixed-powerplant formula, both were intended as weapons carriers, and both were developed to a military requirement.

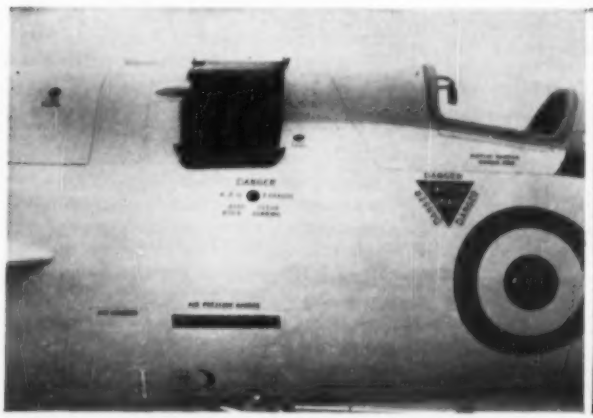
But the little white SR.53s that were shown at the Society of British Aircraft Constructors display were smaller, lighter and less sophisticated than the 177s now under construction.

One Prototype Flying

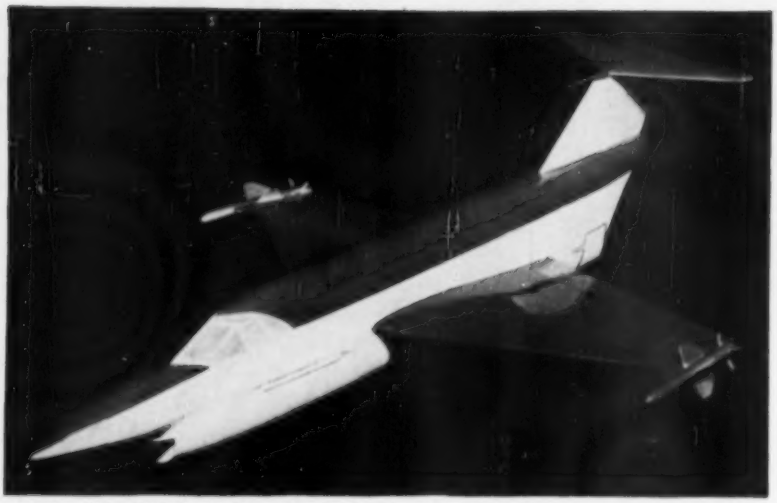
Only the first prototype SR.53 (XD145) is on flight status. It first flew May 16 this year and since that time has only racked up about eight hours. A sizable portion of that time must have been put on during the Society of British Aircraft Constructors display. With average flights running around 20 minutes, this would mean only about 24 flights or between three and four per month. This is not a high utilization rate.

Second prototype (XD151) is due to fly soon. The airplane is completed

FUSELAGE of SR.53 starts with pointed nose. Canopy is hinged at right, swings over top.



ACCESS doors for the SR.53 are clearly marked on the fuselage (left). Spectre is packaged in a unit below turbojet (right).



MODEL of SR.177 shows slab sides, thin wing. Plane has ogival radar nose, ventral inlet with variable wedge for flow control at supersonic speeds. Note knife-edge windshield.

and is getting its final installations now.

No troubles have been reported by Saunders-Roe with either the airframe or the mixed-powerplant combination, and all concerned with the flight tests are delighted with the serviceability of the prototype.

The SR.53 is powered by a single Armstrong-Siddeley Viper turbojet, probably the ASV.8 rated at 1,750 lb. thrust, and the de Havilland Spectre throttlable rocket. Like the SR.177, these powerplants are arranged in an "over-and-under" configuration, but unlike the later model, the turbojet has the top position in the SR.53.

Fuselage of the SR.53 starts with a highly pointed nose, which caused one observer at Farnborough to comment that there obviously was no radar that could get in there. This impression was further strengthened during an interview with Sqdn. Ldr. J. S. Booth, Saunders-Roe chief pilot, who cracked that ". . . the electronics system weighs 180 lb. and drinks gin!"

Cockpit Configuration

The cockpit is small; Booth's big frame fits snugly. The canopy section is hinged on the right side and swings open over the top for access. The flat-front windshield is sloped fairly steeply and its side panels are tiny. Air for windshield-wiping is blasted out of slots at the leading edge of the windshield assembly.

Turbojet inlets are high on the fuselage and behind the cockpit position, in a region where the fuselage boundary layer must be appreciable. Just ahead of the inlet are two sets of slits which presumably serve to bleed off the thick layer of dead air ahead of the intake lip.

The Viper engine is immediately behind the inlets and is reached through a large access plate on the fuselage upper side. A long tailpipe carries the engine exhaust aft.

The Spectre is packaged in a unit below the turbojet tailpipe. Its tankage and the tankage for the Viper are located forward and in the lower portion of the figure eight section.

A T-tail with a remarkably low fin and rudder is mounted at the fuselage rear. The horizontal tail is all-movable, and has a large trimmer or low-speed follow-up surface at its trailing edge with hinges acting also as aerodynamic end plates. The end plate effect of the horizontal tail, plus some increase in vertical fin area due to the jet exhausts, may account for the small size of the tail. One American test pilot commented at Farnborough that the vertical tail seemed inadequate.

Wing Shape

The wing is trapezoidal, with a straight trailing edge and swept leading edges. It is mounted with considerable anhedral. Trailing edge plain flaps are fitted, and the entire leading edge of the wing depresses a few degrees to increase the available lift for takeoff. The wing of the SR.53 is fairly thin by British standards; the SR.177 surfaces may be thinner, and look that way on the model.

Wingspan is 25 ft. 1¼ in., overall length is 45 ft. and height is 10 ft. 10 in.

Services for the mixed-powerplant are clearly marked on the outside of the airplane. A battery of six pressure gages decorates the right-hand side of the fuselage. Five of the gages are calibrated from 3,000 to 4,000 psi., and the sixth runs from 700-750 psi.

High-pressure gages are marked "auto-cutout," "HTP," "cabin," "kerosene" and "Blue Jay;" the low-pressure gage is marked "brakes."

A nitrogen charging point is forward in the nosewheel well; the gas is probably used for pressure-feeding the propellants to the Spectre rocket motor pumps and for purging tanks.

"Blue Jay" is the code name for the de Havilland Firestreak missiles, and the gage probably reads the pressure of the compressed air source used to drive the gyros of the missile before launching.

Under the fuselage is a high-test peroxide jettisoning outlet. On the right side above the bank of gages is the exhaust for the auxiliary power unit, and on the left side below and slightly aft of the cockpit is a fueling point marked "Avtur," the British designation for aviation-grade kerosene, lending credence to the assumption of the refueling boom on the 177.

Design Philosophy

The whole idea of the mixed-powerplant concept is to have an airplane with programmed thrust, so that its flight path can be varied over an extremely wide range to meet the requirements imposed by early-warning systems. One extreme end of that performance range is represented by a long-range interceptor, powered by turbojets and tied to a fixed base with long runways and extensive services. With ample time, this plane can get airborne and climb at moderate speeds towards the enemy.

The other extreme is the rocket-propelled target-area defender, typified best by the Messerschmitt 163 of World War II. This plane is kept on standby status and takes off at the last possible second to blast upward at thousands of feet per minute, slice through a formation in one or two passes, and return to its unprepared base for re-arming and refueling.

The short-range rocket-powered aircraft is now being replaced by the short-range missile, comparable to the Bristol Bloodhound or English Electric Thunderbird in England, or the Nike or Talos in the United States.

Range Requirements

The long-range interceptor is almost valueless to a country like West Germany, which has about five minutes' warning of enemy intentions and another five minutes to intercept. France to a lesser extent, and England to a still lesser extent, need similar airplanes.

In an airplane with a mixed powerplant, the flight profile is determined by the amount of the warning. Initial takeoff and climb can be an all-out effort with both turbojet and rocket

engine throttles at firewall positions. Or the takeoff can be by turbojet alone, and the rocket engine cut in after the plane is in the target area, to increase altitude maneuverability and acceleration.

There was a Royal Air Force requirement for just such a task issued in 1952 for Fighter Command. Since then, the Royal Navy has prepared a similar requirement calling for a mixed-powerplant interceptor for fleet defense.

Saunders-Roe got the development contract after submitting a proposal for what became the SR.53. A. V. Roe & Co. had also designed to the same requirement, but their entry, the Avro 720, was either canceled or not accepted late in 1955.

SR.53 History

Genesis of the SR.53 project was in 1951 with the formation of a design group at Saunders-Roe to study the mixed-powerplant concept as applied to an interceptor. At about that time, de Havilland's engine division had convinced official circles of the need for a mixed powerplant, and had work well along on what was to become the Sprite-Spectre family of rocket engines.

In a parallel circuit, Armstrong-Siddeley was busy developing its Screamer throttlable rocket engine, which was intended to be the rocket component of the Avro 720. The engine was later canceled because of official disapproval of liquid oxygen as an oxidizer in manned aircraft.

Saunders-Roe set up the interceptor project team in 1953 under the direction of Maurice Brennan, chief designer. In July of that year the Spectre first ran on the test stand. Flight tests of the engine began in December, 1956, and in March this year the engine was cleared for flight in the SR.53.

At the controls for the first flight, and in charge of the flight test program for the interceptor, was Sqdn. Ldr. Booth. Royal Navy flight experience is the specialty of Booth's assistant, Lt. Cdr. J. R. S. Overbury, who shares the development flying of the airplane.

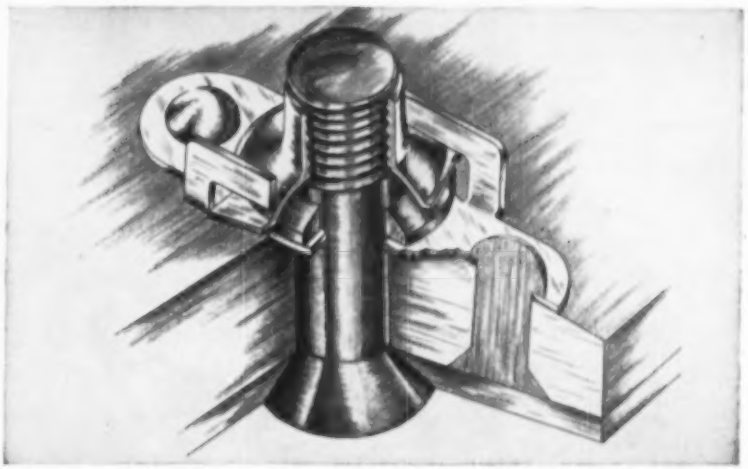
De Havilland Spectre

The de Havilland Spectre exists currently in about five models, three for variable thrust and two for constant thrust operation. It is a neatly packaged, single-chambered unit measuring about 56 in. long and 26 in. wide which increases to about 32 in. including the mountings.

All controls, linkages, fuel pump and oil filler point are on the port side of the engine, permitting easy serviceability.

The major structure of the engine is the thrust cylinder and its attendant assembly which includes the turbine, catalyst chamber and combustion cham-

FASTENER PROBLEM

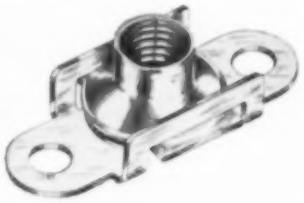


Lightweight floating anchor nut for bolting non-parallel surfaces

THE PROBLEM: Using large single forgings for aircraft bulkheads, wing center sections, spars and ribs offers manufacturers many advantages. It simplifies design and reduces milling costs, and it provides greater strength while reducing air frame weight. However, this type of construction also creates fastening problems. For example, attaching skins and components to these tapered forgings is difficult because the bolt head and seating surfaces are not parallel. Two methods are frequently used to make the fastening areas parallel. They are: 1) spot face machine the seating surfaces, 2) build up each bolt head or nut base with tapered shims. Because there are often hundreds of fastening points, both of these methods are excessively costly and time consuming.

THE SOLUTION: ESNA's redesigned lightweight self-locking anchor nut (Type LHA3022) solves this fastener problem, eliminates these costly, shimming and machining operations and significantly steps up production.

Type LHA3022 consists of a steel nut body with a concave spherical base. The convex seat permits the nut to move automatically with a ball joint action to engage the bolt threads. Two lugs retain the nut in the basket and control the "tilt" to 8° in any direction.



Type LHA3022 is made of carbon steel for use at temperatures up to 550°F. It meets AN-N-10 performance and MIL-N-25027 (ASG) twist- and push-out specifications. Like all Elastic Stop® nuts, it is vibration proof and reusable.

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2330 Vauxhall Road, Union, New Jersey

Please send me the following free fastening information:

☐ Bulletin on self-aligning nut ☐ Here is a drawing of our product. What self-locking fastener would you suggest?

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Firm _____

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ber proper. Forward of this single-piece assembly is a gearbox which mounts centrifugal pumps for feeding the propellants.

Propellants are the airplane's normal aviation kerosene and high-test peroxide. A silver catalyst is used to decompose the high-test peroxide into superheated steam and free oxygen.

Design requirements for the de Havilland engine were tough for rocket designers. Foremost was the variable-thrust rating, from a low figure ("idling," if that term applies here) to maximum thrust of 8,000 lb. Starting and shutdown cycles had to be performed during any flight operation. Duration of maximum thrust had to be on the order of several minutes. The engine had to be rugged, light, simple, easily maintainable and safe and all other usual specifications for aircraft engines had to apply.

Previous Experience

De Havilland's background for the job was largely founded on its experience with the Sprite Jato engine, a so-called "cold" unit which got its thrust and its name solely from the decomposition of high-test peroxide. The oxygen-rich decomposition products suggest burning a hydrocarbon fuel in sort of an afterburner rig, and this kind of approach became the de Havilland Super Sprite.

Carrying the idea a step further produced the basic layout of the Spectre, and de Havilland was off.

In its current form, the Spectre is an operational powerplant, cleared for flight in manned aircraft such as the SR.53 and SR.177. In operation, the high-test peroxide is decomposed by being passed over silver-plated wire gauze packs. A separate high-test peroxide supply is used to drive the turbine which drives the pumps, and the discharge from that unit is fed into the combustion chamber rather than being thrown overboard.

Neither the fuel nor the oxidant gets to the combustion chamber in liquid form. The high-test peroxide is gaseous by the time it reaches the chamber and the fuel, which is used to cool the nozzle, picks up heat in the combustion chamber. Gaseous products ignite more easily than liquids, in general, and the resultant start of the engine is remarkably smooth.

Starting is preceded and shutdown is followed by purging of the combustion chamber by the steam from the decomposition products. This cleans the chamber and eliminates the chance accumulation of pools of liquid propellants.

The Spectre has a single throttle lever, which controls the flow of propellants and therefore the thrust. The engine actually starts producing thrust

VERTOL HUP-2 helicopter, amphibianized by Edo Corp. (AW Oct. 21, p. 32), hovers over Flushing Bay, N. Y., in water tests. Note that bottom Plexiglas windows in cockpit have been replaced with water-tight metal plates to assure proper flotation characteristics.

Vertol HUP-2 Lands on Water

VERTOL Test Pilot Philip Camerano starts to let down in choppy bay waters.

AS HELICOPTER starts into the water, tail wheel kicks up spray.

MAIN wheels, switched from magnesium to aluminum to avoid corrosion, submerge.

AS HELICOPTER fuselage splashes into the bay, Edo-built floats stabilize the craft.

HUP-2 floats easily on water. Note new engine hatch directly in front of rear pylon.

as a "cold" engine, and shifts to the hot phase as more thrust is programmed. The throttle can be shoved back and forth with ease at about the rate customarily associated with conventional turbojets.

Technical Cooperation

The de Havilland Engine Co. has been technically cooperating with Saunders-Roe for several years now, and the Spectre installation is one of the evidences of that cooperation. The parent companies of Saunders-Roe and the de Havilland Engine Co. have a financial link through de Havilland ownership of a substantial amount of Saunders-Roe stock.

Whether or not that stock proves to be a good present investment is not the question, because Saunders-Roe has been operating as a subcontractor to the aircraft industry for years, even though its latest aircraft venture, the Princess flying boats, was a tragic failure through no fault of its own. But for the future, much of the Saunders-Roe hopes must necessarily be riding on the slick white nose of the SR.53 prototypes.

Seventeen years ago, the radar installations on the Isle of Wight were receiving close scrutiny by the Germans and were targets for the Luftwaffe attacks.

Today the Luftwaffe is zeroed in on the Isle of Wight for another reason, looking for help instead of trouble. The SR.177 is one of the prospective answers to its problems.

Rolls-Royce Continues VTOL Test Program

London—Rolls-Royce plans to continue its vertical takeoff test program despite the crash of one of its two experimental "Flying Bedsteads" (AW Nov. 26, 1956, p. 37).

The machine crashed at the firm's flight development establishment at Hucknall when it struck the tethering gantry during a training flight. The RAF pilot checking out in the machine was killed.

The machine was the second prototype jet lift machine. Built under a Ministry of Supply contract, it first flew in October, 1955.

The program will continue with the remaining "Flying Bedstead."

Boyd Joins Westinghouse As Defense Consultant

Maj. Gen. Albert Boyd, deputy commander for weapon systems of the Air Research and Development Command before his retirement on Oct. 31, has joined Westinghouse Electric Corp. in Pittsburgh as consultant and advisor to E. V. Huggins, group general manager, defense products.

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CESSNA AIRCRAFT CO., WICHITA, KANSAS

Cessna

BELL X-2 glides in for landing after speed run. Large nozzles on rocket engines were added to increase their efficiency.

Capt. Kincheloe's Story of X-2 Record

By Capt. Iven C. Kincheloe, Jr.*

The National Advisory Committee for Aeronautics High-Speed Flight Station and the Air Force Flight Test Center have in the past nine years conducted several manned rocket-powered flight test programs involving very high-altitude conditions.

On Sept. 7, 1956, the Bell X-2 rocket-powered research aircraft carried me to approximately 126,000 ft. This height achievement is meaningful in that I had over 99% of the earth's atmosphere below me and the concentration and nature of the cosmic ray particles were the same as in actual space (and therefore space equivalent); it is even more significant when one realizes the X-2 was a ten-year-old aerodynamic design.

X-2 Design

I need not dwell on specific design detail, but the X-2 had both swept wing and tail surfaces. It had a higher performance capability than any other research plane to date. It differed primarily from previous machines in that it had a stainless steel, rather than aluminum alloy, structure.

The first successful powered flight was made in November, 1955, by Lt. Col. "Pete" Everest. The first seven flights were directed toward the high-speed portion of the envelope, in which a speed of approximately 1,950 mph. was attained.)

I was chosen to carry on with the high-altitude-phase testing of the X-2. In four powered flights, the altitude was increased from 45,000 ft. to 126,200 ft. During the build-up flights, and in the preceding seven flights conducted by Col. Everest, considerable data were obtained to be used to predict the aircraft behavior at extreme altitudes.

The ten-year-old aerodynamic design left several areas of desired improvement.

Within the envelope already explored by other research aircraft, such as the X-1 and the previous flight of the X-2, a number of problems had been experienced.

CAPT. I. C. KINCHELOE, JR.

These were low longitudinal control effectiveness, high-altitude dynamic instability, poor control at low dynamic pressures, and deterioration of directional stability at supersonic speeds.

As the X-2 program was a joint effort of the NACA, Bell Aircraft, and the Air Force Flight Test Center, all available data were used and the best engineering talent monitored every flight. The GEDA analog computer was extremely valuable.

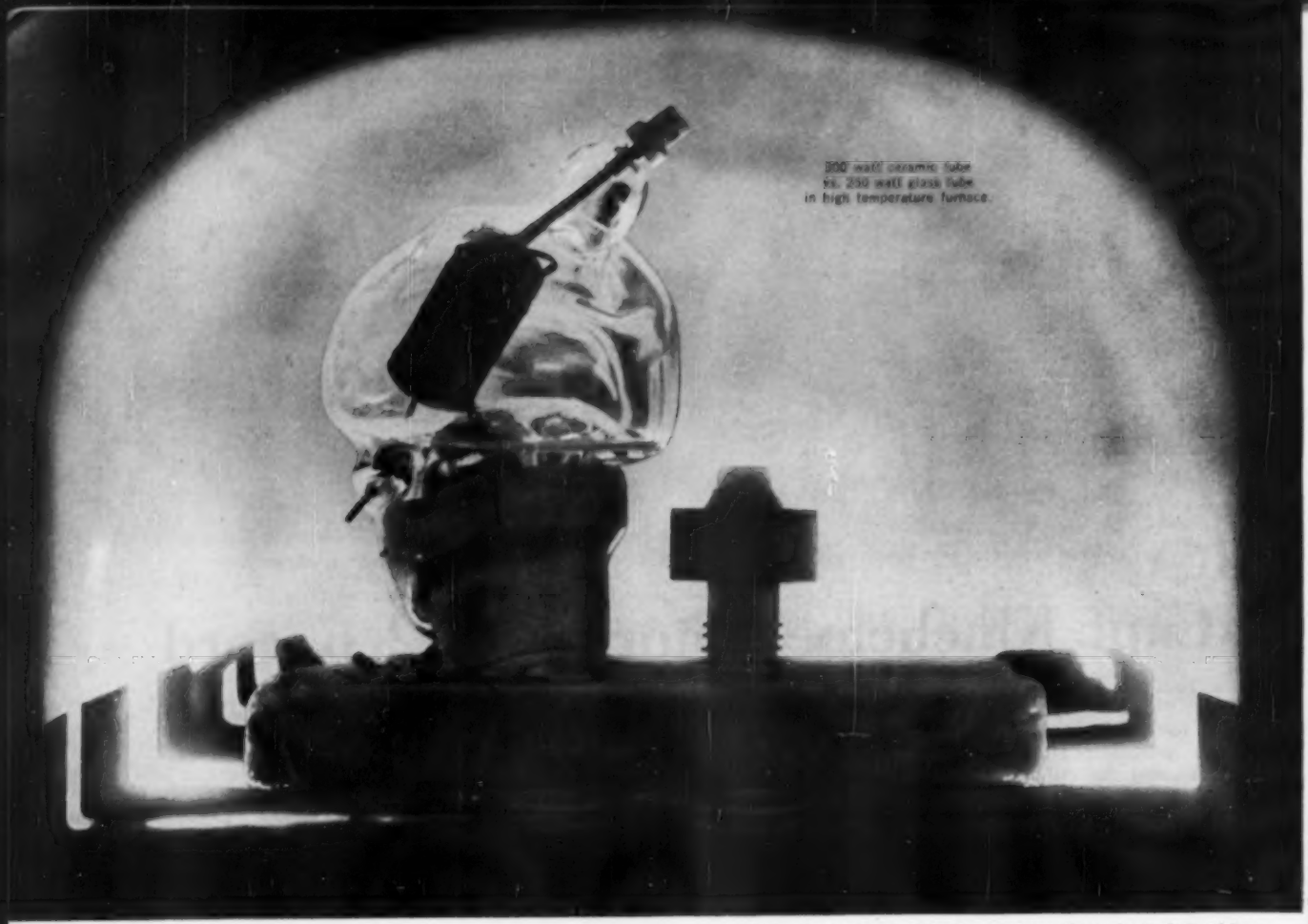
Past experience had shown that in most cases derivatives obtained from flight-test maneuvers performed with the GEDA are close simulations of airplane motions.

Data Sources

Original computer inputs were derived with aid of wind-tunnel and rocket-model tests, manufacturer's estimates, and theoretical predictions available at the start of the program. The stability derivatives were modified after each flight until the simulator would duplicate the flying characteristics of the X-2.

Before each X-2 flight, I was given time at the analog simulator with varying values of the critical stability derivatives. At the higher Mach numbers and altitudes, these variations gave flyable, marginal, and unflyable conditions. As a result of these build-up flights, it was shown that the low longitudinal control effectiveness would limit the climb angle. Therefore, to achieve the optimum altitude, it was necessary to develop the optimum technique to

*Capt. Kincheloe, who delivered this paper at the Seventh General Assembly of NATO's Advisory Group for Aeronautical Research and Development in Washington, flew the Bell X-2 rocket powered research plane to a height of 126,200 ft. in September, 1956. Capt. Kincheloe is an experimental flight test pilot at the Air Force Flight Test Center, Edwards AFB, Calif.



Second in a series describing the advantages of ceramics in electron tubes.

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In a high temperature furnace the difference between a ceramic tube and a glass tube is physically evident. But, long before the glass tube reached the state of complete collapse shown above, it had lost its usefulness as an electron tube.

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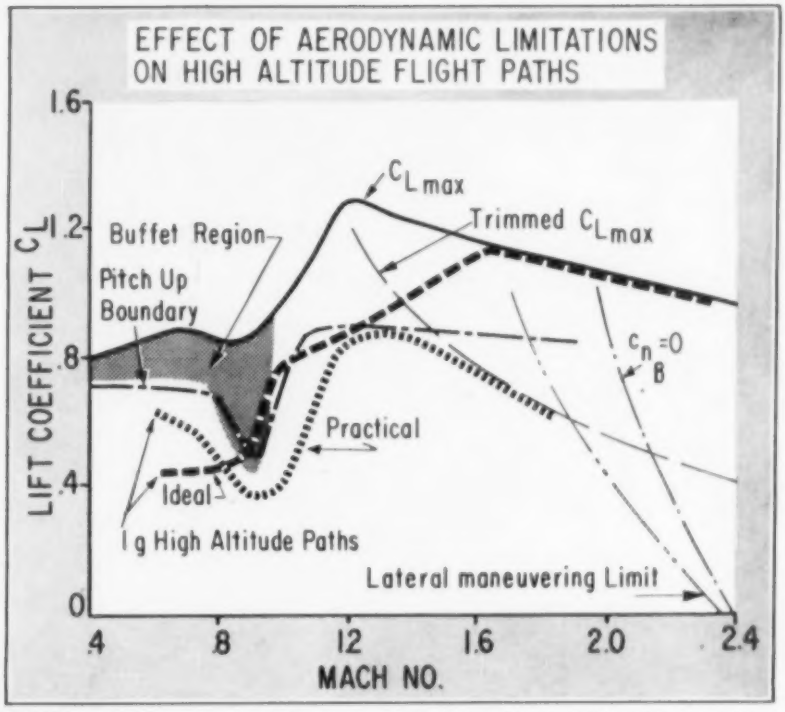


FLIGHT limitations over the X-2's range of Mach numbers and lift coefficients shows buffet region near Mach 1 and that the ailerons should not be used above Mach 2.

be used in establishing the desired flight path. It was also important to learn the proper technique necessary to maintain the desired flight path.

On the particular day of the altitude flight, the weight of the X-2 at drop was around 25,000 lb., with over 13,000 lb. of propellants on board. Since the low longitudinal effectiveness at the higher Mach numbers limited the maximum obtainable climb angle, optimum technique required that the aircraft be rotated to climb attitude in the transonic region. The aircraft responded to stick application and the climb attitude obtained was approximately 45 deg.

Cockpit Layout

Cockpit presentation to the pilot in addition to the normal rocket engine instruments was a standard Machmeter readable to Mach 3, an altimeter with a 100,000-ft. capability, and a standard J-8 gyro. Previous experience with the altimeter had shown considerable error in lag, but the Machmeter indications had proved to be reasonably accurate. The J-8 attitude gyro was generally unusable and proved to be inadequate for the X-2 performance capabilities.

To assist me in determining what attitude I had achieved following rotation, an ingenious device was designed by Bell and NACA personnel to give me a visual observation of the proper climb angle. This was a red grease pencil line, ground-calibrated to be approximately 45 deg., on the canopy Plexiglas. If this line paralleled the horizon, I knew I was on a 45 deg. path.

Even though I had very little control effectiveness available to change the aircraft attitude appreciably, it was still a satisfaction to know how closely I had attained the correct flight path.

Radar Aid

The altimeter was reading approximately 12,000 ft. low at all times in the climb. The actual altitude was transmitted to me by the radar tracking station in 5,000-ft. increments over the radio.

Preflight calculations indicated rocket burnout could be expected around 90,000 ft. As I was approaching the 90,000-ft. area, I glanced at the propellant gages, expecting to see just a few gallons of liquid oxygen and water-alcohol remaining. Instead, I found I had an indication of 75% of my propellant load still on board. In addition to this, I noted a sharp decrease in indicated Mach number from 1.9 to 1.1. If the radar altitude plotting were correct and these visual indications were correct, this meant I was entering a new altitude regime at a Mach number considerably below that desired for safe control, and, for some unknown reason, I had achieved this with very little use of fuel.

During this short interlude of personal consternation the engine did, in fact, shut down as a result of normal propellant exhaustion; the fuel quantity indicating system had gone inoperative at 50,000 ft.

The aircraft continued to climb on a semiballistic path to the peak altitude where the nose rotated slowly downward through the horizon. The aircraft responded as predicted. Within several seconds, we were our way down again. This time, both the Machmeter and altimeter raced in the other direction. The descent was on the order of 86,000 ft. the first 62 sec. Although all available control was used in the pull-up to climb attitude, only about 1.2G was obtainable.

Similarly, in the re-entry and recovery phase, constant pull-up control was used, but level flight was not attained until an altitude of nearly 40,000 ft. was reached. This flight resulted in a considerable period of semiballistic flight. Although 0G was not actually reached, a value of normal acceleration of less than 0.05G was maintained for approximately 50 sec. It seemed to me like a normal 1G condition.

Static Pressures

The present methods of obtaining static pressures are not adequate in areas of extremely low pressure. This inadequacy was responsible for the large error in the cockpit indications of airspeed, Mach number and altitude.

The minimum dynamic pressure for this flight was approximately 18 lb./sq. ft. at the highest altitude. In this condition, the airplane indicated very poor dynamic stability. When the airplane was disturbed by a control application, a pitching oscillation of about 6 deg. with a period of about 6 sec. was excited. Although the damping of this motion was extremely low, the oscillation did not annoy me because it produced no noticeable or appreciable change in normal acceleration, and the attitude was still too steep for me to comfortably view the horizon.

When the peak of the trajectory was attained and the horizon was in view, I had a very quick observation of the general sky conditions. The light intensity within the cockpit and generally surrounding the aircraft appeared to me to be typical of normal 40,000-ft. conditions. Upsun, the sky was blue-black in color and the sun appeared to be a very white spot. The sky conditions downsun were even darker in color.

This dark condition existed to the horizon where a dark gray band appeared very abruptly. This gray band became a lighter until eventually its appearance resembled that of a typical haze condition. The ground within a 60 deg. cone directly beneath the aircraft could be seen very clearly.

Near the peak of the trajectory, a very slight thrust misalignment produced an appreciable left-bank-angle

change prior to burnout. As soon as burnout occurred, this disturbing force ceased.

Previous analog studies indicated bank angles of this magnitude should be corrected very cautiously, because the critical roll rate for divergence is extremely low at very high altitudes as a consequence of the very low magnitude of aerodynamic restoring moments. Roll divergence would be experienced at an average roll rate of 45 deg. per second.

Analog studies indicated that the rate of divergence is slow, but the extremely low control effectiveness would make it very difficult to control the motion.

Severe roll coupling had been experienced in the X-1A at these high altitudes as a result of disturbances produced by thrust misalignment and use of the rudder. Therefore, re-entry and recovery was made from this banked condition with no movement of the controls.

The glide home and standard dead-stick landing was accomplished without incident. Duration of the flight from drop to landing was 16 min., 35 sec.

This review of some of the interesting and significant details obtained during this attitude flight was given to show a few of the NACA and Air Force Flight Test Center's experiences in high-altitude operation. During the discussion it was evident that even though the latest flight testing techniques were utilized, several major deficiencies were existent. Inadequate cockpit presentation for the pilot, low longitudinal control effectiveness, and thrust misalignment were among the critical deficiencies.

This is in no way intended to detract from the praise due Bell Aircraft and the NACA, who in 1946 fixed an aerodynamic configuration which 10 years later achieved an altitude and speed never before attained by man. But it is indicative of the great requirement for increased flight research in the manned rocket field.

P.1 Passes Mach 1 Early in Testing

London—English Electric's P.1 prototypes (AW Sept. 30, p. 50) have been flight tested for stability characteristics at speeds in excess of the 1,132-mph. mark held by the Fairey Delta 2.

Directional stability derivatives, obtained from stick- and rudder-free damping of induced oscillations, were carried out above the world's official speed record by R. P. Beamont, the company's manager of flight operations, who described the experience to the Royal Aeronautical Society here recently.

Beamont said that experience with the U.S. Century series focused attention on the problems of the directional stability of airplanes at high Mach numbers, particularly after the fatal breakup of a North American F-100 with Pilot George Welch.

Flights in the P.1 were made with the prototypes at speeds beginning with Mach 1.2 and increased by increments of 0.05 Mach number. With the airplane trimmed for stable flight, the rudder was displaced with an applied 150-lb. force.

Resulting oscillation of the airplane was allowed to damp out naturally, with stick and rudder free, while instrumentation aboard the plane recorded decay rate, accelerations and displacements about the three axes.

Said Beamont: ". . . the aircraft . . . could be trimmed hands and feet off at these tremendous speeds, and . . . the pilot could become confident in applying uncomfortably large angles of sideslip and then sitting back and watching the aeroplane sort itself out."

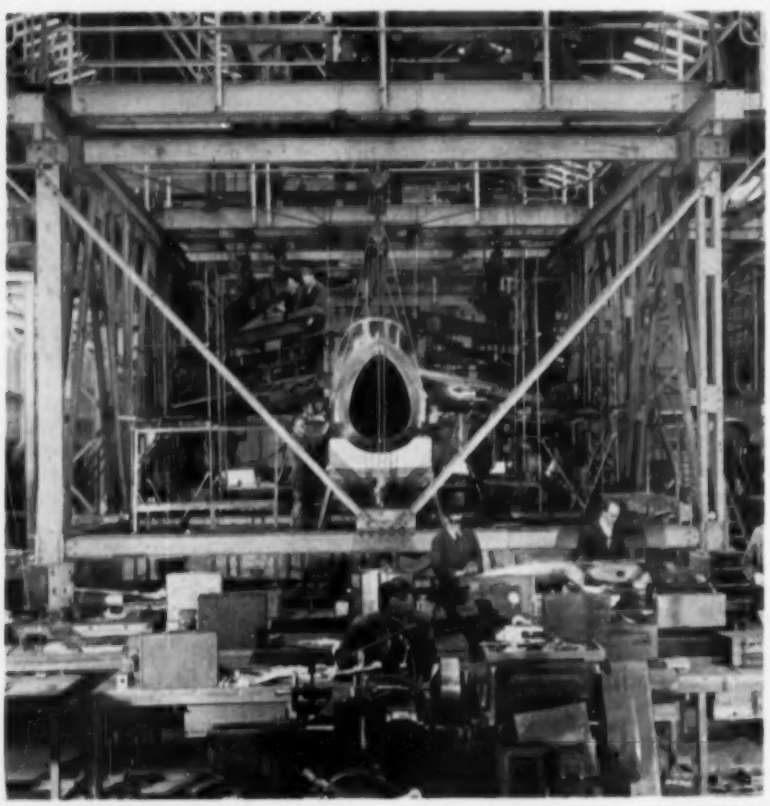
Other points made by Beamont in his lecture to the Society student and graduate section:

• **First prototype** P.1A flew supersonically on its third flight and the first P.1B reached Mach 1.2 on its first flight.

• **It is difficult** to get chase airplanes assigned to a company's flight test program, and normally the pilot has to experience trouble before chase planes will be made available ". . . to observe a subsequent flight for the purpose of reproducing the effect."

• **Flutter clearance** of the P.1 series was done by the Royal Aeronautical Establishment "bonking" method, in which small explosive charges are fired at right angles to the surface being checked during the flight. In spite of the wide use of this method, it didn't preclude fin-rudder flutter neatly bracketed by two scheduled stages of the investigation, and not falling in either. The flutter was cured by changing the fin stiffness and by fitting a viscous damper to the rudder.

• **Adequate RAF** radar monitoring facilities and navigational aids intended for operational aircraft have not been



COMBINED wing and fuselage loading rig is prepared for P.1 at English Electric's research and development center at Warton. Complete aircraft is being tested.

Bounce one off the moon

In a few short years space engineers will bounce a missile off the face of the moon and so glean valuable information on problems of interplanetary space travel. Chances are, Ex-Cell-O parts will help get that missile to its destination, playing a role in this, the conquering of our last great frontier: the universe, itself. Ex-Cell-O builds fuel nozzles, blades, rotors, valves, actuators, fuel controls, parts and assemblies for jet engines.

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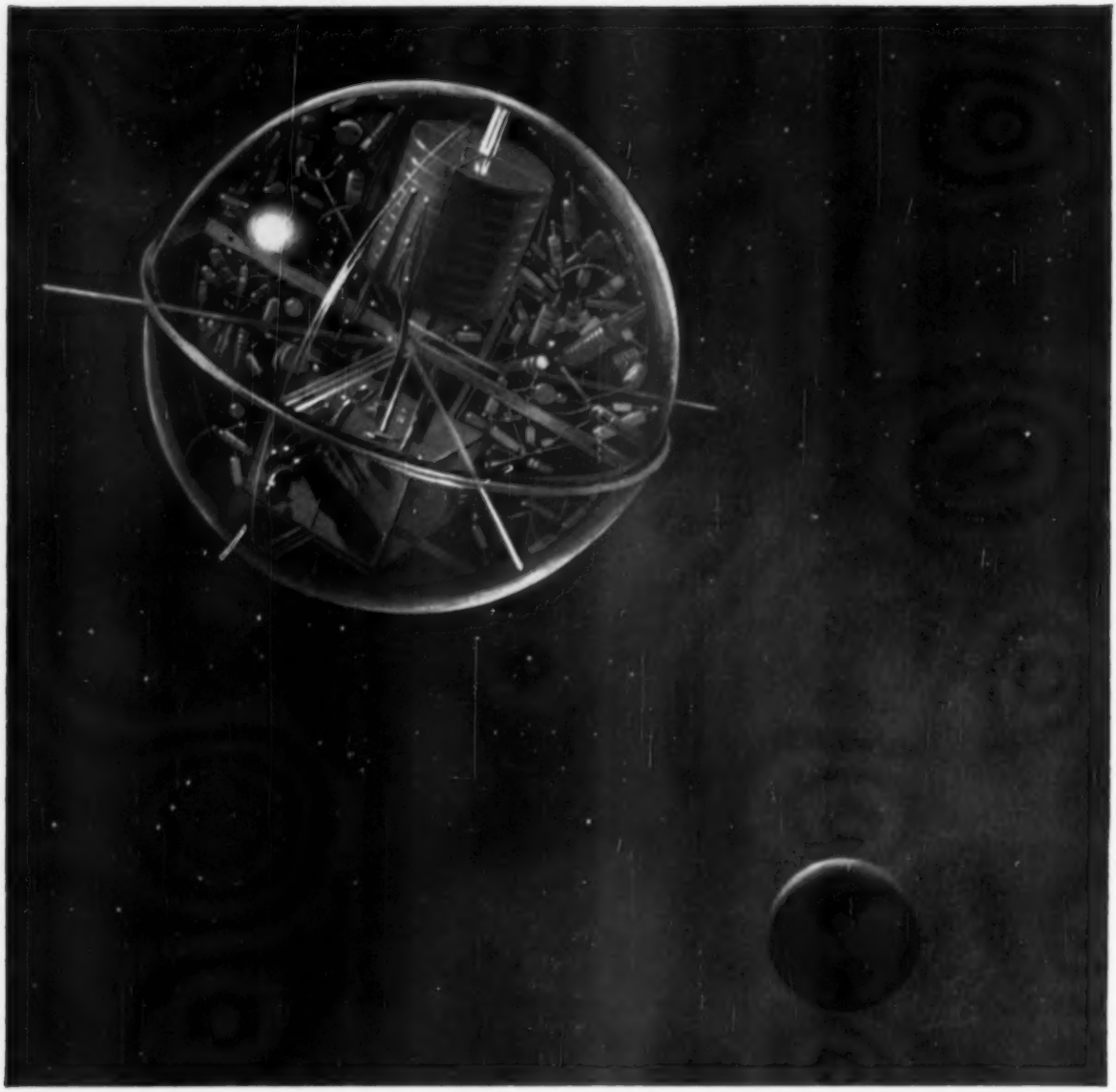

Putting a voice in the man-made moon

America's first man-made satellite will soon be launched into outer space where, traveling in its own orbit, it will circle the earth.

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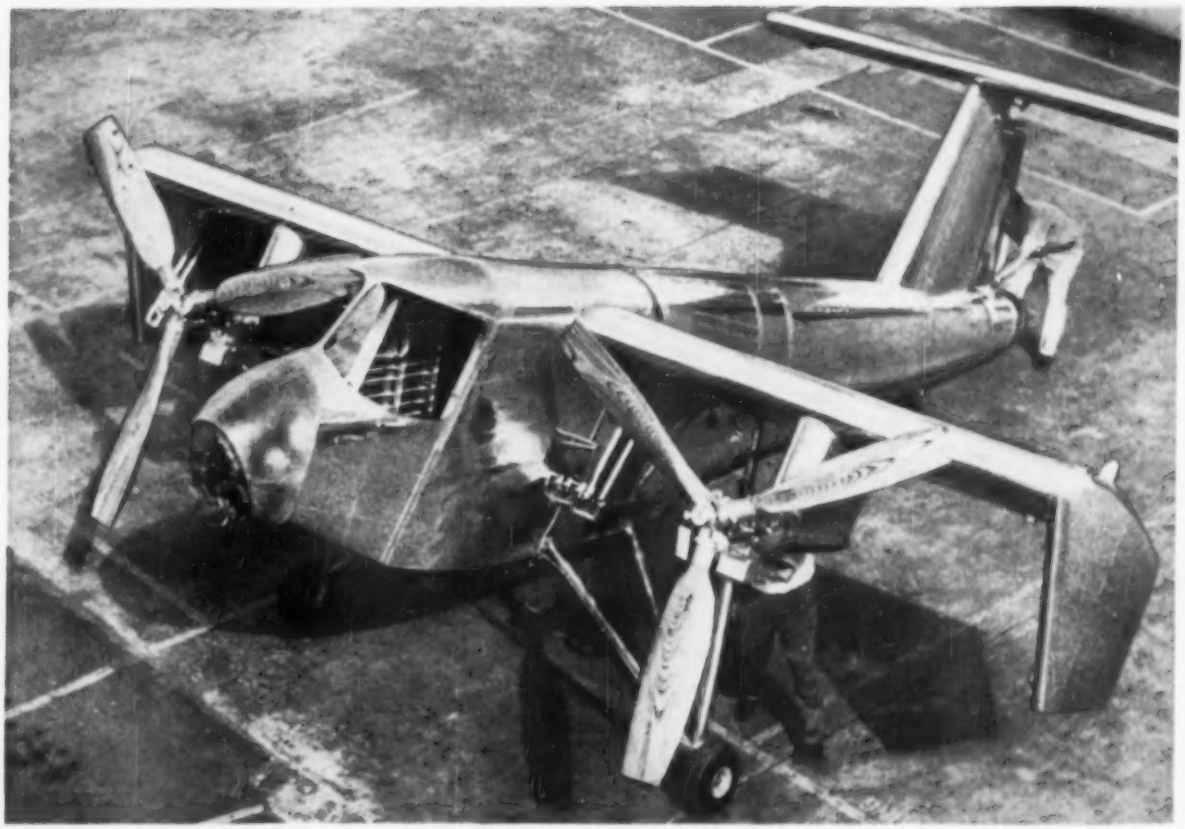

Ryan VTOL Vertiplane Prepared for Test

Two-seat Ryan Vertiplane, designed and built for Army under Office of Naval Research direction, was recently rolled out (AW Dec. 9, p. 37). Aircraft features double retractable wing flaps which deflect propeller slipstream.

available for the P.1 flight test program. Time delay in obtaining VHF fixes is on the order of two minutes because of network saturation; during that time the P.1 covers up to 50 mi. so that the fix, when it does arrive, is largely of academic interest.

• **Transonic problems** have been "virtually nonexistent" because of the low-set slab tail. There is no pitch-up, transition is barely detected at 1G conditions, and even at increased G-loads there is a trim change of less than half a G.

• **Supersonic longitudinal** static stability remains almost unaffected within the pilot's threshold limits, and the only clear indication of change the pilot senses is that he reaches his G limits without achieving a buffet threshold.

Britain Will Cut Back 1958 Aircraft Output

London—Britain's 1958 output of military aircraft will be cut back 9% from this year's level, according to an estimate by Minister of Supply Aubrey Jones.

In a written parliamentary answer, the minister predicted that reductions in military contracts will have little or no effect on the development and production of British civil aircraft.

Jones declined to make a statement on the extent to which spending on research and development may be cut back. "We cannot anticipate the defense White Paper and defense estimates for next year," he said.

The supply minister said he hoped to be in a position to make a statement on research before spring. The scale on which the government will support aeronautical research is now under study by defense officials. Jones said that this is not a "treasury-dominated" inquiry aimed solely at new economics. He said the purpose of the study by senior officials of the departments concerned is to assess the national importance of the industry and, in the light of this and recent defense changes, to make recommendations on future government policy, particularly in regard to government support of research.

Greater integration of the British aircraft industry will be brought about by the government's contract-awarding power, as well as the industry's "own concern for its future well-being."

"The government ought certainly, in my view, to use their position as customers to encourage integration," he stated. "On the other hand, I would consider it quite wrong for the government to suggest that A should associate or amalgamate with B. I am trying to do the first and to avoid the second, which I think is undesirable."

The supply minister also told Commons that formidable problems in the building of a nuclear-powered aircraft have been indicated in a preliminary study made by the Ministry of Supply and Atomic Energy Authority.

"Great expenditure is not considered justifiable at this stage," he reported. The minister said the problems of a nuclear-powered aircraft lie at the moment in the field of fundamental research to a point at which Britain can be satisfied to look to a future line of development rather than to plunge prematurely into applied research.

Assessment of the operational advantages and engineering possibilities of atomic powered aircraft will continue, Jones indicated.

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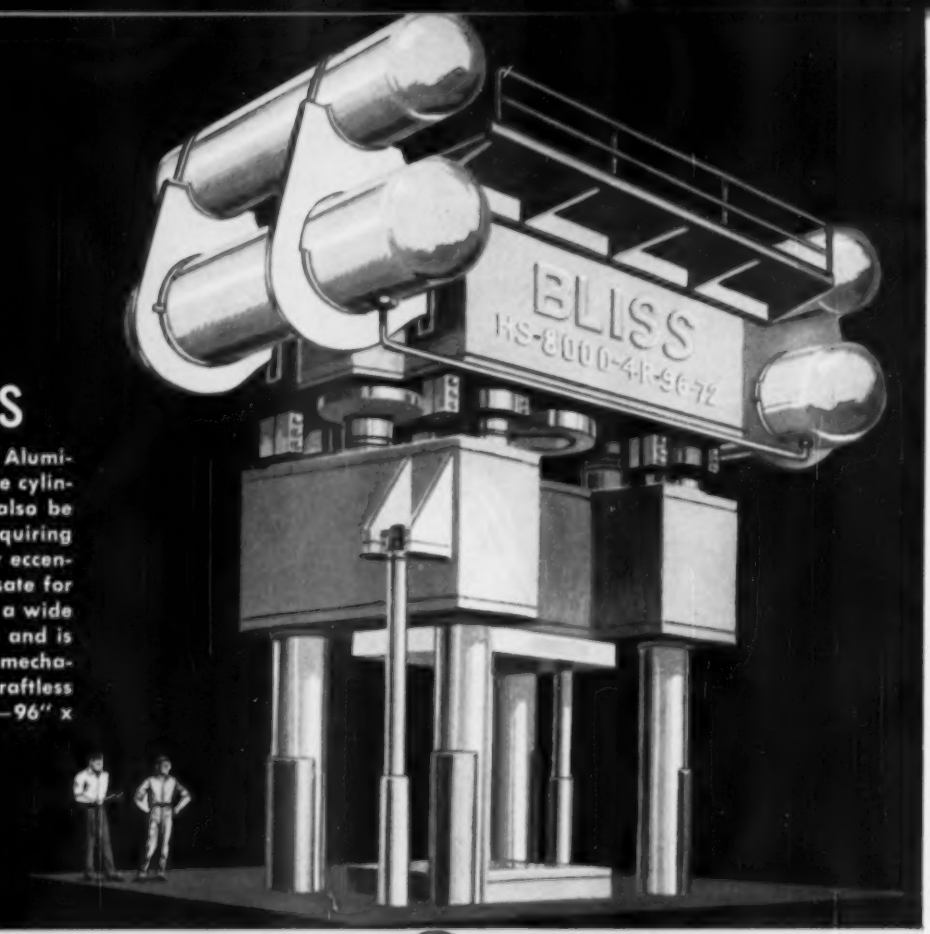

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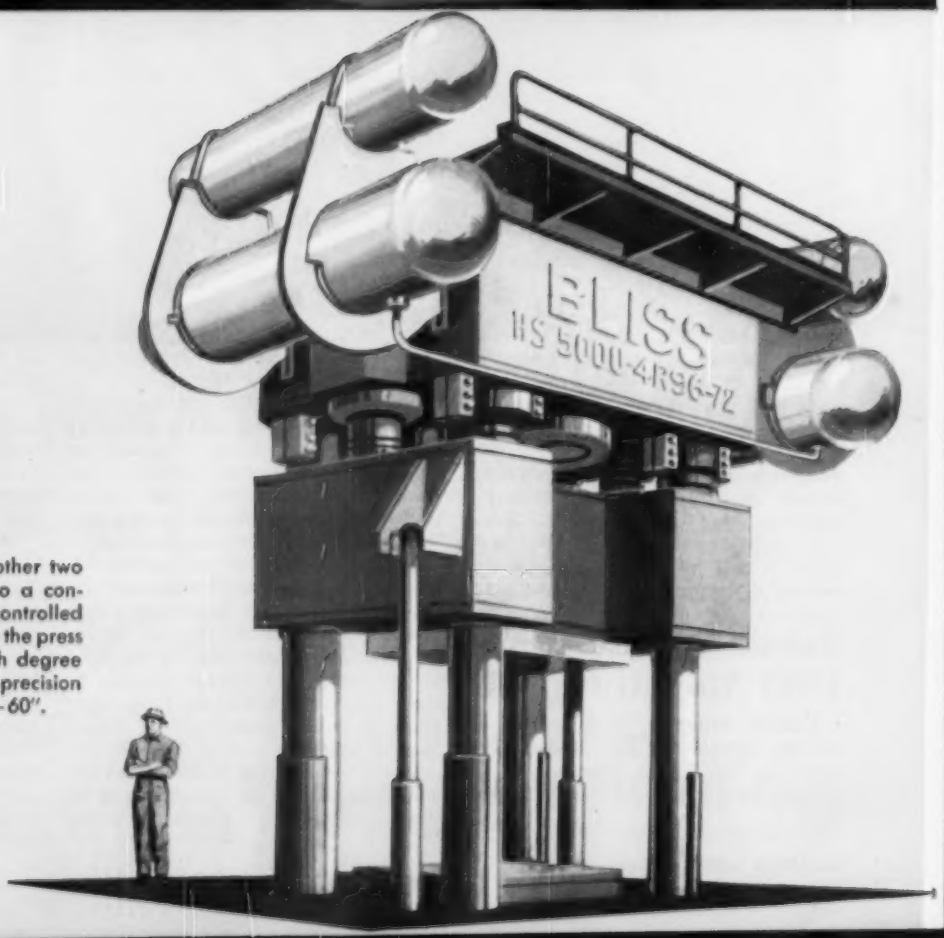
. . . Operates automatically, like the other two presses, through a rapid advance into a controlled pressing speed and after a controlled stroke automatically returns. Thus, while the press operates at high speed, it has the high degree of control and accuracy necessary for precision work. Bolster size—84" x 60", Stroke—60".



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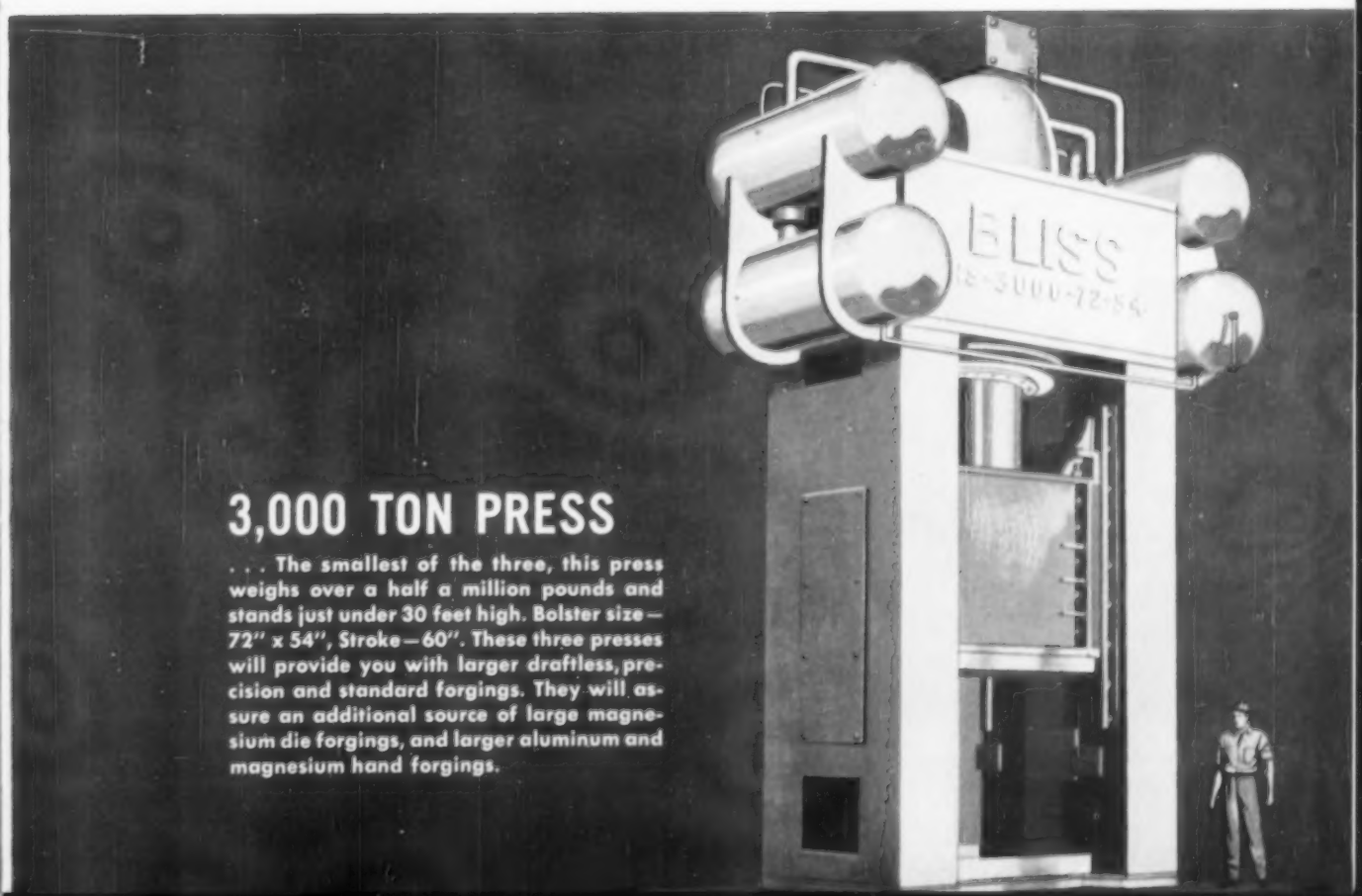

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Florida Grows as Center for Avionics

By Philip J. Klass

Orlando, Fla.—Newly formed Association of Florida Electronics Industry emphasizes the fact that this sunshine/citrus state has become one of the fastest growing centers of electronic-avionic activity in the nation. New association has 20 members with another 40 companies pledged to join.

Climate, a large pool of skilled and/or willing personnel, plus cooperative state and local officials, have attracted such well-established avionic manufacturers as Minneapolis-Honeywell, Sperry Rand and Electronic Communications Inc. (formerly Air Associates).

The Martin Co. recently opened a 488,000 sq. ft. facility here for development and production of avionic systems and small missiles, like the Lacrosse and Bullpup.

Mostly New Firms

But the bulk of the growth, in numbers at least, comes from new firms. Many are headed by engineers who got their first taste of Florida living while working for aircraft/avionic companies at Air Force Missile Test Center, Patrick Air Force Base, Coco Beach. In many cases these new firms set up shop near Patrick to seek contracts for special devices or testing equipment from the center or from missile contractors operating there.

Radiation Inc., one of the early avionic pioneers in Florida, started out in 1950 with a $10,000 contract from Patrick for timing equipment. Last year the firm grossed $8 million.

At present there are no accurate figures on total sales and employment for the 80-odd electronic-avionic companies now operating in Florida, but combined sales probably are around $75 million, including Martin, which is the largest. By way of comparison, California's electronic-avionic industry sales exceed $1 billion annually. More accurate figures should become available if the new Florida association follows pattern of West Coast Electronic Manufacturers Association.

Big Drawing Card

Florida's climate and way of life have proved remarkable attractions for engineers even during the depths of the recent shortage, according to some firms. Honeywell, for example, received more than 4,000 written applications from engineers during the past year seeking positions at the company's new inertial guidance facility near Clearwater, an official says. This was approximately 40 times the number of engineering openings that Honeywell needed to fill.

In addition the company received another 8,000 applications from technicians and engineering aids during the same period, according to Melvin P. Fedders, plant manager.

Electronic Communications Inc. was accustomed to receiving about 25 replies to an employment advertisement placed in the Sunday edition of a New York newspaper, with fewer than 10 good prospects among the number. When company advertisement in same paper announced it was moving from Teterboro, N. J., to St. Petersburg, it received more than 1,000 replies of which about 150 were quality returns, according to Frank Godsey, Jr., company president.

Playing Down Florida

On the other hand, a Martin official says the company did not try to capitalize on the Florida location of its new plant to attract engineers. The reason, according to James W. Bunnell, director of industrial relations at Orlando: "The type of engineer we wanted will be more interested in the job and the opportunity for growth than in the climate."

Bunnell, an old-timer in the personnel business, observes an interesting difference between Orlando and other areas (including California) in which he has recruited personnel. In most localities, job applications are normally discarded after about 60 days because the applicants do not usually remain available for longer, Bunnell says. In Orlando, Martin finds that it pays to keep applications for many months because the applicants are still available six to eight months later when openings occur.

Martin expects to employ around 4,000 when its new facility goes into full operation early next year, but it currently has more than 12,000 applications for jobs on file.

Warm Welcome

Electronic Communications, which currently employs around 500 in St. Petersburg, says it has not had to advertise for factory personnel and currently has a sizable waiting list. Local newspaper publicity about the company's coming led to many job inquiries, and subsequent word-to-mouth advertising by employes brings in more. Many factory personnel, previously dependent upon seasonal tourist industry, are happy to have year-round employment.

Company officials with whom Aviation Week talked all report they have been warmly received by city officials and businessmen. Prior to selecting Orlando for a plant site, Martin officials discussed their industrial needs (roads, water, electric power) and timetable with city officials. The latter agreed to meet Martin's needs and timetable, and have come through on schedule, accord-

LARGEST of Florida's mushrooming numbers of avionics manufacturers is new $18 million Martin Co. plant in Orlando which will develop and produce avionics and small missiles.

HEAVIEST concentration of avionic-electronic manufacturing firms in Florida are in cities shown. However, other cities, like Daytona Beach, are seeking avionic companies.

ing to Edward Uhl, manager of the Orlando operation.

Florida has certain drawbacks for avionics manufacturers, most of which can be cured with time. Geographically the state is remote from major aircraft/missile manufacturing centers as well as from most major Defense Department policy and procurement centers.

Businessmen who are accustomed to speedy communications and transportation are apt to find most areas in Florida extremely frustrating. Long distance telephone connections are made at a pace more fitting to a tourist center than to an industrial site.

Cities in central Florida in which many avionics firms are locating are infrequent whistle stops for the airlines that fly to Miami. One Martin engineer says it takes him 14 hr. to fly from Orlando to the company's plant in Denver. His appraisal of existing airline service: "Miserable."

One recent flight from Orlando to New York, normally a five-hour run, was four hours late in leaving Orlando because of mechanical trouble. Passengers for this airline's preceding Orlando-New York flight were 12 hr. late in departing, also because of mechanical difficulties.

Radiation Inc., with plants at Melbourne (near Patrick) and Orlando, operates its own Aero Commander on regular flights to New York and other major eastern cities.

Supporting Industry

Avionics companies that move to Florida from a metropolitan area also are slowed down by the lack of small supporting industry in the area. For example there are too few machine, tool and die shops, too few certified electroplating facilities, according to Electronic Communications officials.

Martin, which brought down more of its own support facilities, sorely misses the convenient electronic parts suppliers which it had in Baltimore. This is a complaint which other companies also voice.

One of the objectives of the new Electronics Industry Association of Florida is to discover existing, but unknown, supporting industry and it has already turned up several tool and die shops and electroplaters. Another objective is to pinpoint areas where such small businesses are needed, then encourage companies to move in and fill the void.

Tom Grieser of Electronic Communications Inc., who has been active in organizing the new industry group, says his company hopes that within a year it can subcontract approximately 75% of its outside work to Florida firms whereas today only 20% is handled in the area.

Several of the Baltimore suppliers who worked with Martin previously have already moved to set up small-scale operations in Orlando. As the new association makes known the member firms' needs, others probably will follow.

Happy Yankees

Companies like Honeywell, Martin and Electronic Communications which have moved employes from the North to Florida report that the men like their new way of life.

Of 900 engineers and professional people that Martin moved from Baltimore, only two were unhappy and decided not to stay.

Electronic Communications, on the other hand, found that a sizable percentage of its engineers had such strong roots and family ties in the New York area that they didn't want to make the move.

But those who made the move like it, Godsey reports.

For most companies operating in Florida, the uniform of the day consists of sport shirts and slacks. White shirts, ties and coats are seldom seen at work, except on some company officials.

Others keep a clean shirt, tie and jacket hanging at the office just in case a business visitor from the Northland appears unexpectedly.

RADIATION INC., one of the first avionic manufacturers to locate in Florida, has plants in Melbourne and Orlando.

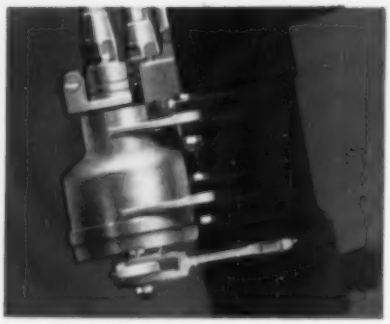
Association of Florida Electronics Industry

Newly formed Association of Florida Electronics Industry has already set up committees to handle four areas of anticipated association activity: In-state procurement, establishment of quality standards, industrial relations and educational facilities.

E. G. Balstraz of Frank C. Brown & Co., management counsel, has been elected president of new organization. Executive directors include: T. F. Grieser, Electronic Communications Inc., P. Painter, Jr., president of Dynatronics, and E. Johnson, president of Johnson Electronic.

Persons interested in obtaining more information about the association may write Balstraz at 1784 West Flagler St. Miami 35, Fla.

POWER STEERING



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This is #6 of a continuing series of advertisements prepared especially for the advancement of the aircraft industry by CLEMCO. Keep a file of them so you will have the complete story by CLEMCO.

Print Unit Performs High-Speed Read-Out

New York—Extremely high-speed printer, capable of producing 85,000 words per minute and suitable for use as a read-out device for digital computers, was demonstrated here last week. New device, developed by Stromberg-Carlson Division of General Dynamics and the Haloid Co., is 5 to 10 times faster than previous printers and roughly 1,000 times faster than a conventional teletypewriter.

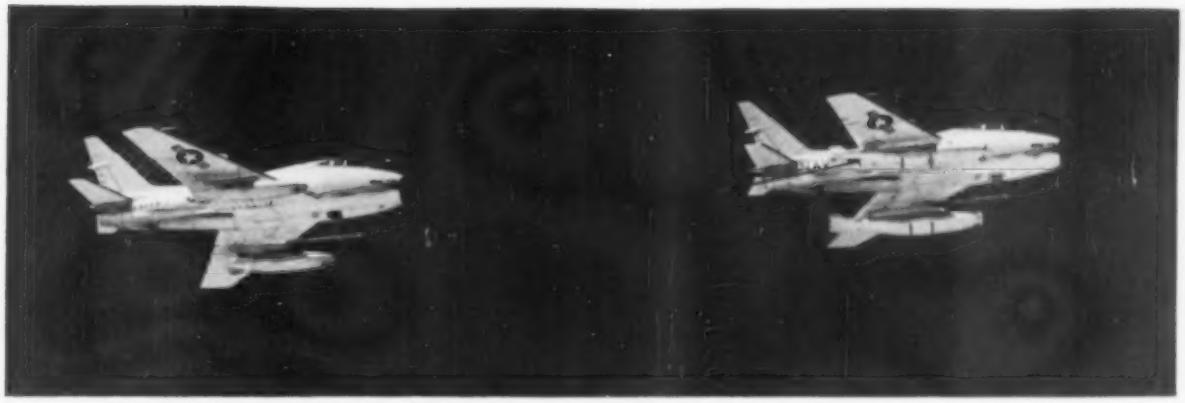
The S-C 5000 printer combines the Stromberg-Carlson Charactron, a cathode ray tube which can display letters, numbers and other characters, with the high-speed Xerography printing process developed by Haloid. The device could be used to produce air traffic control flight progress strips at the rate of 200 strips per second, can produce an 8½ x 11 in. sheet of text in ¾ sec., Stromberg-Carlson says.

Information from a digital computer or magnetic tape is supplied to the Charactron tube which produces the text on the face of the tube, a technique currently used in the Sage air defense system displays. In the new printer, the text on the tube face is optically projected onto a rotating drum whose surface is coated with light-sensitive material which becomes electrically charged in the process.

Fine pigmented powder is then blown over the drum surface where it is attracted to the charged areas, representing letters and characters in the text. This pigmented powder is then transferred from the drum to paper which carries a higher electric charge, after which the powder is fixed for permanency. Machine can print on all grades of stock, from thin tissue to punched cards, company says.

Expansions, Changes In Avionics Industry

Rand Corp.'s System Development Division has been established as a separate non-profit corporation, called System Development Corp., because of the division's rapidly expanding activities which were becoming increasingly outside the scope of Rand's primary function as a scientific advisory group in longrange research for Air Force. New company, a non-profit organization like Rand, will be headed by M. O. Kappler, former co-chief of the System Development Division. F. R. Collbohm, Rand president, will serve as chairman of new firm's Board of Trustees. New company, located at 2500 Colorado Ave., Santa Monica, takes over two major projects formerly assigned to Rand: development, installation and maintenance of



FJ-4Bs Test Buddy Refueling

Navy FJ-4B Fury fighter at left is being refueled by FJ-4B carrying additional fuel tanks to serve as buddy system tanker. Receiver aircraft climbs to 25,000-40,000-ft. altitude for rendezvous with tanker FJ-4B. Tanker trails hose with drogue, and receiver slips probe on left wing into drogue. North American Aviation's Columbus Division is conducting day and night tests.

Sage air defense system training program and the programming of Sage computers.

Other recently announced changes, mergers and expansions in the avionics field include:

• **Cornell Aeronautical Laboratory** will establish a branch office in Washington to study problems in military electronics.

• **Midwestern Instruments, Inc.**, Tulsa, Okla., has purchased total assets of **Data Storage Devices Co.**, Van Nuys, Calif., and will move new acquisition to Tulsa. F. A. Oliver, former owner of new acquisition, becomes a vice president of Midwestern.

• **Stanford Research Institute** will establish a Naval Warfare Research Center at its Menlo Park, Calif., facility to perform operations research, systems analysis and weapons evaluation for Office of Naval Research.

• **Cohu Electronics, Inc.**, San Diego, has purchased two instrument manufacturers, both of Schenectady, N. Y. **Millivac Instrument Corp.** and **Volkers & Schaffer, Inc.**, the new acquisitions, will be merged into single operating unit to be known as Millivac Division of Cohu Electronics. Dr. Walter Volkers, formerly head of the firms, remains as president of new division and becomes vice president of Cohu. New acquisitions are expected to complement parent company's instrument line and increase sales volume by more than 25%.

• **General Controls Co.**, Glendale, Calif., has established new integrated engineering, manufacturing, sales operation in its new Electronic Controls Division.

• **Tipptronic, Inc.**, maker of electromechanical devices, has moved its operations from Chagrin Falls, Ohio, to 2808 Van Aken Blvd., Cleveland.

• **Servomechanisms, Inc.**, New York City, has licensed Mitsubishi Electric Co., Tokyo, to manufacture certain of the company's airborne computing devices.

• **Allen B. DuMont Laboratories, Inc.**, Clifton, N. J., has reorganized its Research and Development Division into eight specialized laboratories, under central direction of Robert T. Cavanagh. New laboratories include: advanced development under Richard C. Palmer; systems laboratory under Robert Wakeman; communications and radar lab under William Sayer; data and display laboratory headed by Robert Deichert; military television laboratory under John Auld; nuclear instrumentation under Mr. Cavanagh, and mechanical laboratory under Bernard Amos.

FILTER CENTER

▶ **Infrared Collision Avoidance**—Minneapolis-Honeywell is working on infrared system which shows promise of providing automatic collision warning as well as proximity warning. Aerojet General system, now starting flight evaluation, provides only proximity warning and does not discriminate between aircraft which are or are not collision threats. Honeywell system will be described at upcoming Air Transport Assn. meeting, Jan. 9, in Los Angeles.

▶ **Soviet Electrical Engineering**—English translation of most important papers appearing in Russian journal Elektrichestvo (Electrical Engineering) will be available from Pergamon Press, 122 East 55th St., New York 22, N. Y., at $17 per volume. English version will be available shortly after appearance of Russian edition as result of special arrangements made with USSR Ministry of Electrical Power Stations. Articles cover power supply systems, electrical machines, switchgear, measuring instruments and automatic control.

▶ **Signed on Dotted Line**—Major contract awards recently announced by avionics manufacturers include:

• **Aeronutronic Systems Inc.**, Glendale, Calif., has received Civil Aeronautics Administration contract to design and build a Flight Data Entry equipment (Fliden) which will enable flight plans and aircraft position report data to be entered into an automatic traffic control computer by means of a standard teletypewriter.

• **Lear** reports a $2 million Navy contract for its AN/AJB-3 low altitude (LABS) bombing system. Company also announces a $5.4 million contract from Air Materiel Command for its new master attitude reference system.

• **Hamilton Watch Co.** reports a $2¼ million contract from Hughes Aircraft Co. for production of signal data recorder equipment to be used in tests of the Falcon air-to-air missile.

• **Ford Instrument Co.** has received a $13.8 million contract for additional production of its AN/ASN-7 dead-reckoning navigation computer.

▶ **Pill for Pallid Programmers**—Homespun remedies for the ills of electronic computer programmers are being published monthly under the title "The Compleat Programmer," by ElectroData

ELECTRONIC

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MEASURES

Over
20 years' experience
in development and manufacture
of systems and equipment
for airborne, ordnance,
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Division of Burroughs Corp., Pasadena, Calif. Handbook provides information of interest to both student and experienced programmers working with ElectroData computers. Copy is available on request.

► **Capital Refits DC-3s**—Narco Sapphire 1016 VHF communications receivers and transmitters have been selected by Capital Airlines for installation on its fleet of DC-3s. Equipment provides 560 receiving and 360 transmitting channels with 50 kc. channel spacing.

► **New Vibration Pickup**—Capacitance-type vibration pickup, which is small, easily calibrated and can be constructed in a variety of shapes, has been developed by National Bureau of Standards. One Bureau of Standards model can measure vibration amplitude as small as 0.1 angstrom, equal to about $\frac{1}{10}$ the diameter of a hydrogen atom, and has been calibrated over a frequency range of 10 to 40,000 cps. New pickup and associated calibration procedures were developed by W. Koidan of National Bureau of Standards' sound laboratory.

► **Defense Electronics Gain**—Defense Department expenditures for electronic equipment during Fiscal 1957 are estimated at $3.5 billion, compared to $2.8 billion spent in Fiscal 1956. Figures, prepared by Electronic Industries Assn. (formerly RETMA), are based on rule-of-thumb formula for estimating percentage of Defense dollars allocated for aircraft, missiles and ships which go to electronic-avionic manufacturers.

► **"Picture" Transmission by Teletype**—Device which permits speedy transmission of "pictures" of weather fronts, battle lines and similar situations using standard teletype machines has been developed by University of Michigan's Engineering Research Institute under Defense Department sponsorship. Weather front or battle line to be transmitted is drawn across a map on a plotting board. Teletype operator scans this line through a transparent grid, then sends out a number which represents direction of the first segment of the line. Number is received at other terminus and automatically converted into corresponding line segment on cellophane sheet placed over map of the sector involved. The sending operator then moves on to next segment until entire front or battle line is drawn on receiving cellophane overlays, thereby creating copy of original map. An irregular line on a 12-18-in. map can be transmitted by this technique in 3 to 7 min. compared to 20 min. required to transmit entire map by facsimile machine, University says.

Ground-Testing Flight Controls

British pilot (right) and technicians test the complete flight control system of de Havilland Aircraft Co.'s new Continental and Intercontinental Comets. Full-scale rig, built at the firm's Hatfield plant, exactly duplicates operation of a plane's elevator, aileron, rudder, air-brake and wing flap hydraulic circuits under all normal and emergency flight conditions. Circuit geometry is checked, results analyzed and bugs eliminated. Empennage units aft of the rear pressure bulkhead have been checked at temperatures as low as —58F. De Havilland also is using the rig for endurance testing of the entire system to determine service life. This involves continuous operation of the entire system for tens of thousands of operating cycles extending night and day over a period of several months. Purpose is to accelerate certificates of the new Comets.

American Plans New Idlewild Terminal

New York—American Airlines' proposed $14 million passenger terminal at New York International Airport will include telescopic passenger corridors connecting aircraft doors and departure lounges. The facility is scheduled for completion by mid-1959.

Under the plan the covered bridges, which American says are now under development, will be positioned at the end of fixed corridors leading from the lounges onto the ramp.

For airplane loading, the bridges will swing toward the plane through 90 deg., extend and fit against the rear door of the aircraft. They will be powered by electricity.

At the same time, fixed loading passageways will connect the front doors of planes with the lounges. Thus passengers can enter their planes at either end while under cover. The lounges are at door level.

The airline plans to taxi its Boeing 707s, as well as its Lockheed Electras, into the gate positions. For departure, engines will be started and the planes pushed away from the terminal by special vehicles which will be attached to nose landing gear. The planes then will taxi out for takeoff.

At departure, the rear loading corridors are contracted and pivoted back into their original positions.

Lounges are located along two concourses leading out from the main terminal structure.

The facility will handle up to 16 Boeings, American says.

Entrance to the street side of the terminal is approached via vehicular ramp which brings the passenger to boarding level as soon as he enters the building.

Whole concept of the terminal is centered around the passenger rather than the airplane, according to the airline.

American plans to use pre-loaded baggage containers which will be electrically hoisted into the belly compartment of its aircraft. Containers will be removed from arriving aircraft and moved by the lower level to the baggage claim area.

Loading corridors will be made as sound-tight as possible to protect passengers from jet noise.

The terminal will be fully air conditioned, according to American's plans. A 30-ft.-high glass wall will run the length of the field side of the building. Restaurants and other concessions will be located in the main structure.

APPROACH to terminal is at second level, from which passengers enplane.

CONCOURSES lead to ramp, contain departure lounges for passengers.

LOUNGES connect directly to aircraft with covered passageways.

Zenith's new radome test range – finest in American industry.

Bring your tough ones to Zenith

Do you have a radome or antenna that you can't test accurately enough with your own equipment? Then bring it to Zenith's new radome test range.

Here, at your disposal, is the largest, most advanced test range in America – and the experience Zenith has gained in testing more radomes than all other companies combined.

The central test building and the four permanent towers on Zenith's new range are 60-foot, double-deck, concrete-and-steel structures, with foundations sunk deep in the earth to eliminate vibration. Two additional towers are portable, so that Zenith can make tests on 18 different ranges – plus a special, long-range setup for giant radomes like those on the Navy's Lockheed Constellations. Many tests are made on automatic equipment. And a system of elevators and dollies provides for fast, safe handling of radomes.

Zenith is best known for the integrated work it has done in the design, manufacture, and testing of resin-bonded glass fiber components. By making and testing more than 100,000 radomes, we have learned how to form resin-bonded glass fiber in almost every shape and size – and how to put it on the production line.

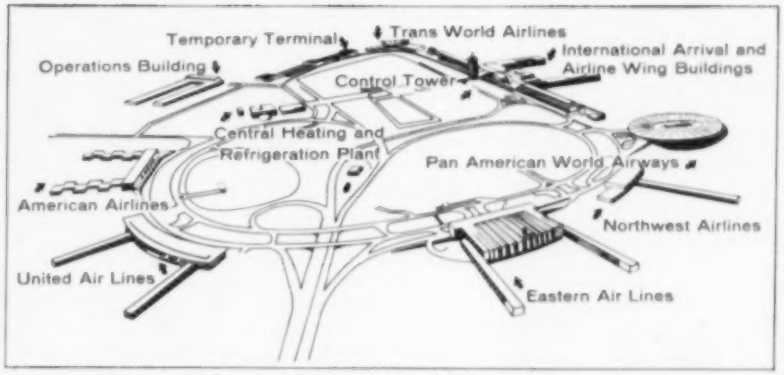
But each of our services – research, design, development, engineering, manufacturing, testing – is also available separately. We invite you to "bring your tough ones to Zenith."

World's largest plant producing reinforced plastics components for the U. S. Air Force, U. S. Army, and U. S. Navy. Applications include Aircraft and Missile Radomes • Helicopter and Missile Fuselage Sections • Aircraft and Missile Wings • Fairings • Fuel Tanks • Fire Bombs • Rescue Containers • Bomb Casings and Fins • Rocket Launcher Pods • Antenna Reflectors • Arctic Shelters • Boats • Minesweepers • Landing Craft • Small Sailing and Power Craft • Naval Craft Components • Buoys and Floats • Ducting • Ground Rigid Radomes • Land and Aerial Mine Housings • Shipping Containers • Storage Tanks

Zenith Plastics Company

1600 West 135th Street, Gardena, California
Subsidiary of Minnesota Mining and Manufacturing Company

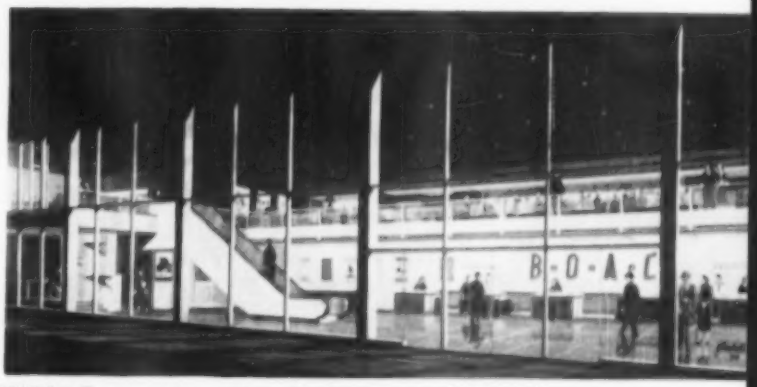
FORM OF THE FUTURE: RESIN-BONDED GLASS FIBER



IDLEWILD'S new International Arrival and Airline Wing buildings (right) are part of "terminal city" under development (left).

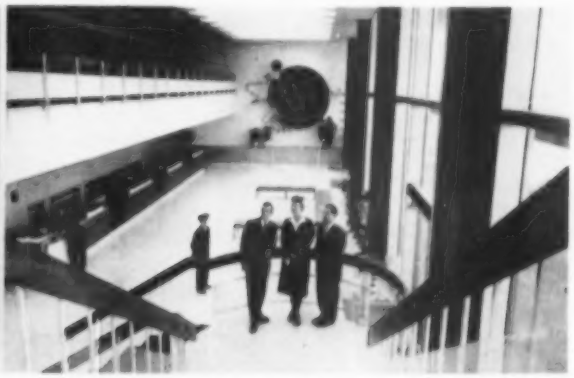
New York Opens International Arrival Building at Idlewild

New York—Port of New York Authority has opened its $30 million International Arrival and Airline Wing buildings at New York International Airport. All arriving passengers requiring federal clearance and all foreign-flag airline departures will be handled from the new structures. Customs facilities in arrival building feature 32 conveyor-equipped checkout counters in each of two customs halls, and self-claim baggage racks. Fourteen foreign carriers lease space in the wing buildings. New buildings are major elements of overall 655-acre terminal city development which will include individual terminal buildings of U. S. domestic airlines. Arrival and wing buildings provide 24 gate positions, with ground floor for flow of incoming passengers and second floor outgoing passengers. Buildings are three stories high, with total length of 2,300 ft. When development is completed, it is expected to provide 140 gates.



BRITISH Overseas Airways Corp. departure area is glass-fronted.

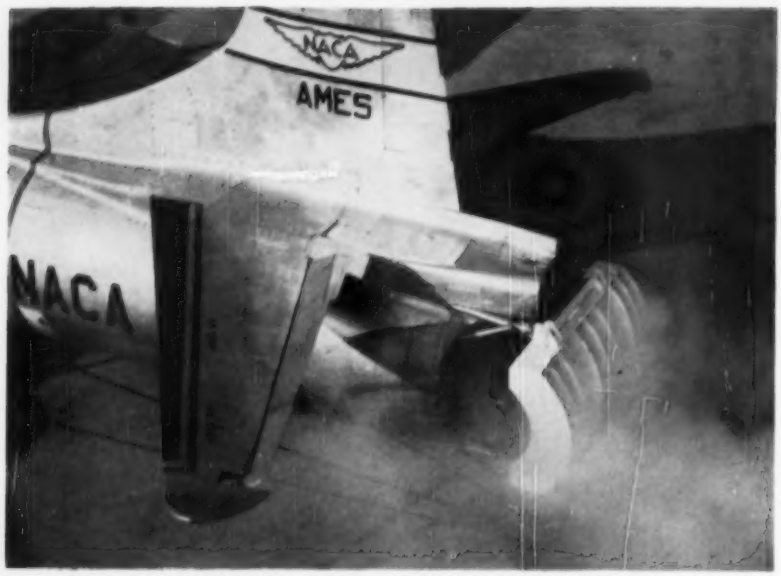
AIR FRANCE first class lounge is "Parisian Room."



KLM stresses contemporary design.

IMMIGRATION, Naturalization rooms are plush.

SAS lounge contains 7,000 sq. ft.



SMOKE shows F-94C exhaust flow with thrust reverser fully closed.

NACA Flight-Tests Reverser Unit

Moffett Field, Calif.—Thrust reverser that gives high performance jet aircraft precision control over the approach glide path and touchdown point has been demonstrated on a Lockheed F-94C by National Advisory Committee for Aeronautics' Ames Aeronautical Laboratory here.

Full modulation provides the new feature of instantaneous, in-flight control which is useful not only in landings but could be utilized by carrier aircraft for quick acceleration after a wave-off, NACA said.

The new thrust reverser also is useful for cutting landing roll significantly, being utilized in the way that reversible propellers are on piston engine transports.

Demonstration was made after 20 proving flights. Metal clamshell type door mounts on the tail pipe. Fully open, it allows maximum forward thrust of 6,000 lb. Fully closed, it reverses 3,600 lb. of the thrust to the braking direction. In flight, engine rpm. is kept constant and reverser is adjusted to control glide path, eliminating sluggish response of jet engine to throttle changes.

Current flight tests follow basic wind tunnel studies conducted at NACA's Lewis Flight Propulsion Laboratory several years ago.

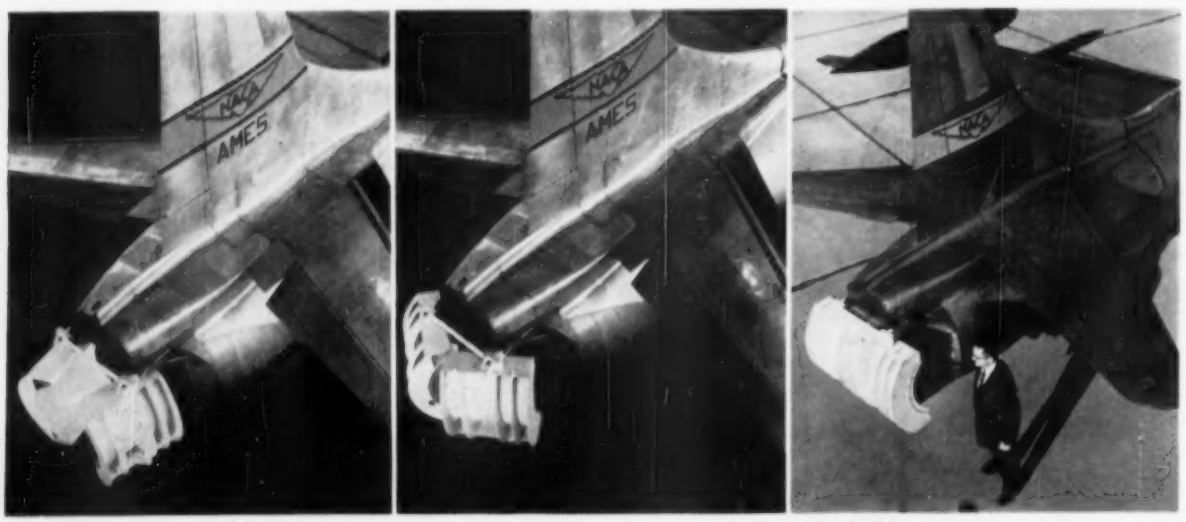
PRODUCTION BRIEFING

Republic Aviation, Farmingdale, L. I., is starting construction of its 6,000 sq. ft. research facility which will house a 3,000 mph. supersonic wind tunnel. To cost $1.2 million, the windtunnel is scheduled to be in operation by mid-April, 1958.

Metals Processing Division, Curtiss-Wright Corp., Buffalo, N. Y., employs techniques used to produce hollow extruded propeller blades to make integral solid propellant chamber-body structure missile shapes. Advantages are high production rates with lower unit costs and possibility that flanges left on the expanded propeller-section shape can be used as points of attachment for missile wings or even act as limited aerodynamic surfaces themselves. The Metal Processing Division is also working on various forms of hollow cooled turbine blades.

Lockheed's Missile System Division will begin staffing its remote 4,000-acre test site in the Santa Cruz mountains, south of San Francisco. Fifty engineers and scientists from Lockheed's Sunnyvale location will move in as soon as the main administrative building is completed, in December. By the end of 1958 it is expected that the staff will grow to between 150 and 180.

Janitrol Aircraft Division, Surface Combustion Corp., says construction is now underway on manufacturing, engineering, research and testing buildings in Columbus, Ohio. Completion of the 130,000 sq. ft. plant is anticipated by early spring. Together with the high-altitude test facility, the new buildings will cost $2 million.



CLAMSHELL reverser is shown fully open (left), partially closed for landing approach (center), and fully closed (right).

NEW AVIATION PRODUCTS

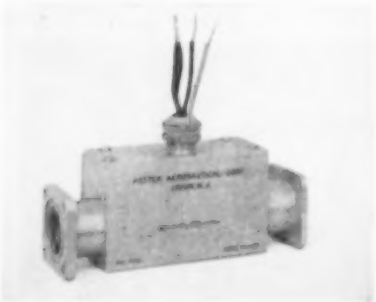
Pickup Coils

High temperature pickup coils are designed to operate at temperatures up to 850F without special cooling. For use at 1,000F temperatures, an air-cooled pickup coil is available.

Signal lead-in wires are permanently welded to the coil and are protected by a flexible stainless steel sheath. Units are also designed to withstand continuous thermal shock caused by temperature variations down to −450F.

Mechanical motion can be converted into electrical energy without direct contact by placing the pickup coil near a turning gear, shaft keyway, screw, pin or slot. Coil produces an a.c. signal whose frequency is proportional to the rate of motion of the object.

Potter Aeronautical Corp., Union, N. J.



Precision Flow Switch

Model FS-26 precision flow switch, available for installation as original equipment in military aircraft to indicate fuel transfer from auxiliary to main tanks, is an in-line device capable of handling any of current jet fuels.

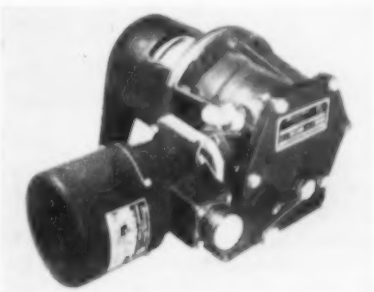
Where compressed air or gas is used as pumping medium, the new switch will indicate immediately when air enters the line, signaling completion of fuel transfer; reverse flow has no effect on switch function. Unit is designed to operate in temperatures of −100F to 450F.

Potter Aeronautical Corp., Union, N. J.

Small Time Delay Relays

New line of sub-miniature hermetically sealed time delay relays, designed for aircraft and missile applications, provides settings of 1 sec. to 1 hr. on d.c. units and from 15 sec. to 3 hr. on 400-cycle units. Up to three switches can be supplied in the basic design of these devices. Basic weight of one switch is 7½ oz.

A. W. Haydon Co., Waterbury, Conn.



Airborne Hoist

Airborne hoist, weighing under 18 lb., holds two nine-foot ⅛-in. cables which can be spooled a three to six feet per minute rate with a 400 lb. load, according to the manufacturer. Unit is designed to operate in −65F to 165F temperature range.

Model 1118R1 hoist is powered by a 200-v. a.c. 400-cycle three-phase motor.

Western Gear Corp., Lynwood, Calif.

Low-Cost Lab Furnace

For small melts and testing of small samples at temperatures up to 2,650F, compact furnace for laboratory use is priced at less than $100, including a gas-mixing device.

Unit is fired by any natural fuel gas and air under low pressure and is chambered for crucibles up to 4-in. base diameter by 2¼-in. high.

Selas Corporation of America, Dresher, Pa.

Tracking Blinker

Tracking device that provides brilliant, short-duration flashes of light is seen by manufacturer as being useful in providing location of airborne drones, missiles, target planes or balloons. Consisting of photoflash lamp assembly and pulsing circuit that can be remotely located, entire equipment weighs 4 lb. and is available for 28, 14 or 7-v. d.c. systems.

Ambient temperature range is −55 to 130F up to 55,000 ft. Circuitry is shielded to prevent interference.

Research, Inc., 115 N. Buchanan Ave., Hopkins, Minn.

Solid State Battery

Miniature high-voltage solid state battery, Dynox 95, can supply a steady current of 1 x 10⁻⁹ amp for 176,000 hr. at 70F with only a 10% current drop or a flash current of 20 microamperes, according to the manufacturer. Firm also notes that units can be stored

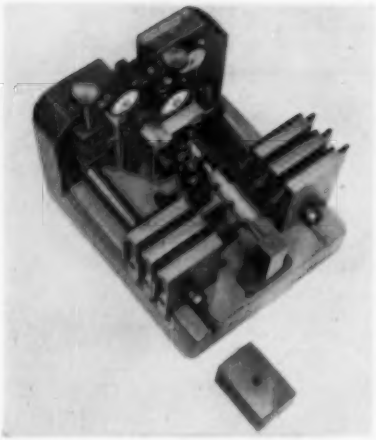
20 years without losing power.

Equipment measures 1¼-in. x ¾-in. diameter and has a potential of 95 v. in 0.14 cu. in. Batteries can be assembled to meet special dimensional and electrical requirements. Maker cites availability of units that can furnish 625 v. per cu. in. and be drained continuously five years at 5 x 10⁻⁹.

Moos Division, Universal Winding Co., 90-28 Van Wyck Expressway, Jamaica 18, N. Y.

Jet Blade Gage

Universal precision gage for checking jet engine blade accuracy features airfoil template holders that are adjustably mounted on hardened and ground ways on the device. Template holders are positioned by interchangeable master gage bars, enabling any length blades to be checked while consistently



maintaining template alignment accuracy of 0.0002-in., the manufacturer states.

The templates engage the foil section of the blade to indicate form accuracy as well as blade tilt and bow.

Shepard & Young Tool Co., 15150 Telegraph Rd., Detroit 39, Mich.

Compact Cooling Package

Joining a circulating fan to a heat exchanger of large capacity provides a cooling unit for airborne electronic equipment, that, in one version, weighs only 2.5 lb. and measures 7 in. x 6 in. x 3 in. Fan circulates air through the heat exchanger where it is cooled and forced over the electronic components. Liquid or ram air may be used in the heat exchanger as the cooling agent.

AiResearch Manufacturing Division, The Garrett Corp., Los Angeles, Calif.

Lightweight Hoist

A 35-lb. winch with a self contained motor and lift capacity of 6,000 lb. is small enough to be carried in one hand, the manufacturer asserts. Model 61 has a reel-in rate of 10 fpm. at capacity load of 6,000 lb. Load speed combinations vary; at 3,000-lb. load the unit reels in at 20 fpm.

Unit was designed to meet Mil-E-5272A specifications.

All American Engineering Co., Box 2668, du Pont Airport, Wilmington, Del.

Tape-Controlled Drill

Numerically controlled automatic drilling machine is designed to position within 0.005 in. true position tolerance repeatable at accuracies of 0.001 in. over a maximum length of 40 in. and maximum diameter of 50 in., while being positioned at rate of 60 in./min.

Unit, built to General Electric Gas Turbine Division specifications, is being installed at General Electric's jet engine plant, Evendale, Ohio, where it is expected to reduce setup and machining time by about 74% on J79 and CJ-805 components.

Punched tape directs drill motions.

Barnes Drill Co., 834 Chestnut St., Rockford, Ill.

Low Pressure Switch

Low pressure differential switch of all-aluminum construction can be used with liquid or gas and is available to handle settings from 1-22 in. of water or 0.1-5 in. of mercury. Fixed actuation valves range from 1.25-12 in. of water.

Weight is 1¼ lb., diameter is 6⅛ in. and depth is 3¾ in. Switch has an external adjustment.

Meletron Corp., 950 N. Highland Ave., Los Angeles 38, Calif.

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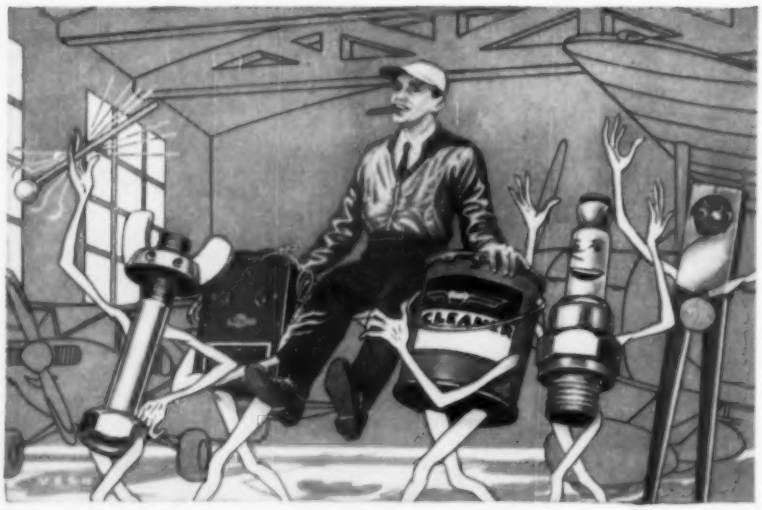

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AIR ASSOCIATES

British Ministry of Transport Accident Investigation:

British Crash Tied to Lax Check Flights

The Viking twin-engined aircraft G-AJBO (normally called Bravo Oscar) involved in this accident was owned by Eagle Aviation Ltd., serviced by Eagle Aircraft Services Ltd. and under charter to the Air Ministry.

On the evening of May 1, 1957, this aircraft was due to take off from Blackbushe, an airport controlled by the Ministry of Transport and Civil Aviation (hereinafter referred to as the MTCA), on a trooping flight to Idris in Tripoli. It had a crew of four, comprising Capt. Jones, First Officer Tunnington, Radio Officer Robertson and a stewardess, also one supernumerary crew ranking as a passenger, and in addition 30 passengers who consisted of service personnel, women and children.

The weather was fair with no cloud under 3,000 ft., the wind was slight and from the north but visibility was only moderate—it was in fact 2.4 nautical miles which was described as indifferent, or neither good nor bad.

The aircraft took off up wind at about 2115 G.M.T. and two minutes later reported a failure of the port engine and that it was intended to make a circuit to port and land again. Having completed the down wind and base legs of this circuit the aircraft crashed in a wood just as or just after it had turned to its final approach and at a distance of about 1,200 yd. from the threshold of the runway. Thirty-four of the 35 persons on board lost their lives.

It is necessary to restate the above bald account in more detail in order to consider the implications of the facts. Before the aircraft took off a number of the staff of Eagle Aviation Ltd. spoke to Capt. Jones, who appeared fit and well, and one of them who spoke to him immediately before the aircraft was started observed that he had taken his seat on the port side, this being the seat normally used by the captain of a Viking aircraft.

Prepares for Takeoff

At 2108 hr. G.M.T. (2208 hr B.S.T.), by which time it was fairly dark and the runway lights were on, Bravo Oscar asked for taxi clearance and in reply the control tower at Blackbushe Airport gave permission for the aircraft to taxi to the holding point for runway Zero Eight and at the same time informed the aircraft that the Q.N.H. was 1021 millibars.

By this the air traffic controller meant that the barometric pressure at Chatham, the station into whose area the flight would normally proceed, was as stated—the Q.N.H. being given in order that Capt. Jones might set his altimeter accordingly once he had taken off from Blackbushe and attained a suitable height.

Shortly after 2114 hr. the control tower, which had in the meanwhile given instructions as to the course to be followed, informed Bravo Oscar, which had by this time reached the threshold of the runway, that it was clear for takeoff with a right turn out.

This message was acknowledged by Bravo Oscar at 2114.53 and within a few seconds thereafter it was observed to make the run and take off.

Zero Eight runway at Blackbushe lies almost parallel to the Camberley-Basingstoke Road but to the north of it and the aircraft was taking off from west to east; that is, from the direction of Basingstoke toward Camberley.

At 2116.44 Bravo Oscar called the control tower and on receiving its acknowledgment passed the following message at 2116.52 (almost precisely two minutes after takeoff): "I have got a port er engine failure I am making a left hand circuit to come in again."

A minute and a half later at 2118.16 the control tower, which had been taking energetic action to clear the runway of other aircraft, received the message: "Bravo Oscar is down wind" indicating that Capt. Jones had successfully turned left-handed and was flying westward parallel to the runway.

To this message the air traffic controller was able to reply, "Bravo Oscar clear to final number one"—that is to say, to land as soon as it was ready to do so. He followed this message, which was duly acknowledged, by informing Capt. Jones that the surface wind was Zero two Zero at seven knots.

At 2119.08 the aircraft, having acknowledged the message in regard to the wind, asked for the Q.F.E.—that is, the barometric pressure at Blackbushe itself, which would govern the altimeter setting for landing.

At 2119.13 the aircraft sent its last message acknowledging the Q.F.E., which had been given as one Zero one Zero.

Shortly afterwards, at 2119.47, the control tower record shows the following entry: "Transmitter switching—unmodulated." A few seconds later a Viscount aircraft (Hotel Kilo), which was stationary in a lane near the runway, passed a message that it had seen Bravo Oscar, adding "I have lost sight of him on the approach very low."

Reported on Fire

By 2120.28 this message was supplemented by the further report "We have him there, he is on or it looks like him on fire."

In fact, as the airport fire services found when they reached the scene some few minutes later, Bravo Oscar had crashed some 1,200 yd. short of the runway threshold at a point south of the Basingstoke Camberley Road but directly in line with the extended line of the runway.

The account of the crash given by the only survivor, 2d Lt. Taylor, describes the steady turn to port after the takeoff, throughout which he could watch the lights of the runway, the message from the captain given by the stewardess that there was trouble with an engine and that they were turning back to land again, and then the final scene in the following words:

"After a time, which I cannot estimate exactly, the aircraft banked very steeply to port. I could still see the runway lights when this occurred. A little later there was a tremendous shudder throughout the whole length of the aircraft, almost as if a gigantic hand had seized the aircraft and shaken it. A few seconds later the aircraft struck the ground. I am satisfied that when the shudder occurred the aircraft was banking to port. I am also satisfied that the shudder was not caused by the aircraft striking anything by its very nature and because enough time elapsed between the shudder and the crash on the ground for me to turn round and say something to reassure the children who were sitting behind me.

"Immediately after the crash I looked at my watch and it was 2225 hr. The stewardess, after giving out her message to the passengers, had sat down on the tip-up seat attached to the door of her cabin and strapped herself in.

Climbs out Window

"I had noticed that the window next to me was labeled 'Emergency Exit—Push' so I knocked it open and climbed out. I ran a few yards and then turned back toward the aircraft. It was not then on fire and I heard someone shouting 'Get the children out.' I ran back to the window I had climbed through and shouted 'Pass the children through here.' There was no answer and at that moment there was a terrific explosion somewhere to my left and burning fuel was sprayed all over and around the aircraft so that the whole area within a radius of about 50 yd. from the port engine was in flames. I scrambled over the tail of the plane to the starboard side and when I was about 20 yd. away from the aircraft, I looked back again. The whole aircraft was on fire and there was clearly nothing I could do. At that moment I saw Capt. Routledge emerge from the flames and, as he was on fire, I ran toward him, grabbed him and rolled him on the ground to put the fire out.

"Just after this a man who I now know to be Mr. Marsh, rushed up to me and said that I was on fire too. He pulled my buring clothes off and then went to the aid of Lt. Andrews who was also burning. Shortly after this, the ambulances arrived and we were taken to the Cambridge Hospital at Aldershot, where I am still a patient."

In fact the fire caused by the exploding fuel caused such severe injury to the other passengers that none has survived the crash, and 2d Lt. Taylor was at the date of the inquiry still in hospital. The engines were so severely damaged that it is necessary to

exercise extreme caution in assessing any evidence to be derived from their condition.

Apparent Failure

The story which I have outlined shows that this crash was preceded by the apparent failure of the port engine some two minutes after takeoff. The crash itself occurred about three minutes later when the aircraft, having almost completed its circuit, had reached a point about 1,200 yd. short of the threshold of the runway to the line of which it was turning preparatory to coming in to land.

It is convenient to record that as a result of his most skillful and painstaking investigation of the scene of the crash, Mr. Cameron-Douglas, a senior investigating officer of the Accidents Investigation Branch of the Ministry of Transport and Civil Aviation, was able to establish that the aircraft struck the ground first with the port wingtip and then, having attained an inverted position, severed the top of a tree with the starboard wing following which it doubtless lost both wings and swung round so that the fuselage came to rest pointing back in the direction from which it had come.

The evidence adduced in the course of the inquiry was directed to two main issues: first to the question whether, and if so why, the port engine failed, this evidence covering airworthiness of the aircraft, its loading and trim, the condition of its engines and in particular the question of their proper maintenance. Second, evidence was directed to the question of why this aircraft crashed where it did. A Viking twin-engined aircraft should be capable of landing without undue difficulty on one engine. I was accordingly required to consider the competence of the pilot and first officer, the course followed during the circuit with particular reference to height and speed, the lighting of the airport and the precise circumstances of the crash.

It is, I think, convenient to deal first with the aircraft itself and the question of its condition and maintenance.

History of Aircraft

Bravo Oscar was first licensed in 1947 and was acquired by Eagle Aviation Ltd. from the British European Airways Corp. (hereinafter referred to as BEA) in 1954. The current certificate of airworthiness was issued May 11, 1956, and was not due to expire until May 10, 1957. The last major inspection (Check 4) was completed Feb. 4, 1957, and at the time of the accident the aircraft had flown 488 hr. since that date.

Both engines were well within their approved life, which is 1,500 hr. after a complete overhaul. The port engine was completely overhauled by Bristol Aero Engines Ltd. on Oct. 16, 1956, since when it had run some 662 hr. The starboard engine had had a similar overhaul Dec. 3, 1956, and had since been run for 488 hr.

It may not be universally known that in the course of a complete overhaul the whole engine is normally taken to pieces and reassembled with a replacement of such parts as the Aero Engine Co. (in this case the Bristol Aero Engine Co.) think necessary. In the result, any engine which has been overhauled several times may well contain few, if any, of its original components.

In short these engines probably bore little, if any, relationship to those installed in the aircraft in 1947 and were well within the span allowed by their makers. The propellers were also well within their approved life.

I heard a body of evidence in regard to the maintenance of the engines and the aircraft generally. With the assistance of my assessors, this evidence was scrutinized with great care and in the result I am satisfied that this aircraft and its engines had been properly maintained.

The evidence put before me and which I accept, was to the effect that Bravo Oscar had had a complete Check 1 of the whole aircraft, including its engines, carried out Apr. 27, 1957, following which a certificate of maintenance was issued which was valid at the date of the accident. Following this check the aircraft was flown to Palma Apr. 28 and returned via France and Germany to Blackbushe on the 29th, having flown for some 14 hr. During this flight certain minor snags were noted by the pilot.

On Apr. 30 and May 1 a further complete Check 1 was carried out since, as it happened, the engineers had time available. During this check a few matters left over from the 27th, and also the minor snags noted by the pilot during the flight on the 28th and 29th, were all rectified and the engines fully checked. I am satisfied that at about 1400 May 1 both engines were run in the presence of a representative of the Bristol Aero Engine Co. and proved entirely satisfactory. I am further satisfied that they were run again to the proper test revolutions at about 2000 that evening, and 2d Lt. Taylor's account makes it clear that they were again run by Capt. Jones before takeoff.

Engine Fire Damage

Within a short time after the crash the fuel caught fire as previously described, with resulting severe damage to the engines. In the circumstances it was impossible for the experts of the Accidents Investigation Branch of the MTCA to ascertain whether the port engine had in fact failed and, if so, why. Certain factors could be shown to be satisfactory: the spark plugs of both engines were still in working order and all those parts which could be examined appeared to have been properly lubricated. It is fair to say that no evidence of failure to maintain was disclosed by such examination as could be made and in the light of the history of the operators and their service company it would be entirely wrong to assume that, if in fact the port engine failed, this was due to any fault of their engineers. The company has since 1950 carried over a quarter of a million passengers without injury to any one of them and such a record could hardly have been attained without efficient and conscientious maintenance.

A great deal of evidence was advanced as to the loading and trim of the aircraft. It is quite clear that this aircraft was properly loaded and trimmed and if there was any excess weight at the time the aircraft actually left the ground it was so trivial—at most 20 kilograms—that it could not possibly have contributed to this accident.

To sum up: this aircraft was, in my opinion, provided with a valid certificate of airworthiness and a valid certificate of maintenance. It was properly loaded and trimmed, and it was properly maintained.

Why the port engine failed, if it did, must remain a matter of pure speculation—the evidence is quite insufficient to enable any conclusions to be drawn. It is always possible for example that the pilot's decision to regard the engine as having failed may have been due to the failure of some instrument, and not to the actual failure of the engine itself.

One-Engine Procedure

While it must necessarily remain the subject of conjecture, it seems likely that at the time the port engine was considered to have failed the aircraft had attained a height of between 500 and 700 ft. According to the performance schedule of this aircraft it should have been capable, with the load carried, of climbing on one engine at the rate of 155 fpm. or, if that engine was run continuously at takeoff power, at the rate of 250-300 fpm. According to the operations manual, the ideal height when turning on to final approach should be 700 ft. when landing on one engine, and the speed should not be allowed to fall lower than 110 kt. (109 being described as the minimum effective control speed) until the decision to land has been made.

The cardinal principle in making a landing with one engine inoperative is to avoid an undershoot, namely the position where the pilot after turning on to final approach finds himself with insufficient height and speed to reach the runway. The fact that one engine is inoperative renders the aircraft power asymmetric so that, if as in this case the port engine is dead, it tends to fly port wing low, this tendency increasing as the speed drops. Thus if the speed is low it is obviously dangerous to bank steeply, especially in the direction of the dead engine.

In these circumstances, when landing a twin-engined aircraft with one engine only, the practice is to maintain height and speed so as to enable the approach to be made more steeply than with two engines, it being remembered that once the undercarriage and/or flaps are let down the difficulty of regaining height or speed is far greater than when the power of two engines is available. For these same reasons if the circuit is being made at a low height it is desirable to fly a tight circuit so that the aircraft may not be too far from the threshold of the runway when the turn on to final approach is made.

Weighing Evidence

If the aircraft loses flying speed it will stall, this event being preceded by "noticeable buffeting" to use the wording of the operations manual, or "shuddering" to adopt the more graphic term employed by a witness. There can be no doubt that this aircraft undershot the runway and stalled port wing down some 1,200 yd. from its threshold. Is it possible on the evidence to reach a firm conclusion as to the reasons which caused it to do so?

As I have said, there is evidence from a number of witnesses who saw and spoke to him before the flight that Capt. Jones was fit and in every way normal before he took the captain's seat on the port side of the aircraft preparatory to the flight. At 2116.52, at which time Bravo Oscar informed the

control tower of the port engine failure and that it was making a left hand circuit to come in again, it is reasonable to assume that Capt. Jones would have already taken the appropriate action which would include feathering the port propeller. That the propeller had been feathered was confirmed on examination after the crash. In the course of the inquiry it was suggested that Capt. Jones ought to have attained more height before attempting the circuit and that he ought to have made his circuit to the right, namely against the live engine, instead of to the left.

It must be recognized that the failure of an engine shortly after takeoff is rare and represents a serious emergency for the pilot. It may be true that to land the aircraft in such circumstances is, as one experienced captain said "part of the job," and that it merely requires, as another put it, "a somewhat higher degree of concentration than for a normal twin-engined landing." The fact remains that a pilot has a short space of time in which to make a number of difficult decisions.

Pilot's Decision

Capt. Jones decided to turn to port at once rather than to attempt to gain further height before doing so. I do not think his decision to turn to port was wrong and indeed I am inclined to think it was entirely right. Although turning against his dead engine, Capt. Jones was turning in the normal circuit direction and, since the emergency occurred at night, a turn to port had this great advantage that it enabled him (while sitting in the captain's seat on the port side) to keep the lights of the airport in view whereas, if the turn had been to starboard, this would have been far less easy. In the absence of any certainty as to the height he had attained at the time he started his circuit it would, I think, be entirely wrong to criticize his decision.

The course followed by the aircraft has been described by a number of witnesses. Second Lieutenant Taylor, the sole survivor, describes the steady bank to port, during which he himself sitting on the port side was able to keep the lights of the airport in view. Capt. Langley, who was in charge of another Viking of Eagle Aviation Ltd. and was waiting close to the threshold of the runway to take off, saw Bravo Oscar as it crossed the eastern end of the airport to turn down wind and again when it turned on to the base leg and from that on to final approach. This pilot formed the view that when it turned down wind Bravo Oscar "seemed to have sufficient height." He noticed no violent change of height during the circuit but only a "gradual descent into the last stages of final." He did, however, form the view that Bravo Oscar overshot the approach originally and had to turn back to port again, although it was not a violent turn.

He regarded the aircraft's circuit as in no way unusual.

Capt. MacKenzie, a pilot of BEA who was also waiting to take off in the Viscount Hotel Kilo, but whose aircraft was some 600 yd. further from the crash than that of Capt. Langley, also saw Bravo Oscar, but not until it turned on to base leg. While watching the aircraft at this point and thereafter as it turned on to final approach, he formed the opinion that the aircraft was rather lower than he himself would have wished to be in that situation. He observed that it was steadily losing height until it disappeared behind the hill on its approach; at the time, as he judged, it was making a turn to port into line with the runway.

Those who heard the various messages from Bravo Oscar on the radio telephone, namely Capt. Langley, Capt. MacKenzie and the two air traffic controllers, all agree that none of them disclosed any sort of anxiety or tension, while nothing emerges more clearly from the statement of 2d Lt. Taylor than the absence of any indication that the aircraft was in serious jeopardy.

No Anxiety

The obvious conclusion from this body of evidence is that from the moment that Bravo Oscar turned to port it made its circuit certainly without gaining and probably while losing height steadily. No sort of anxiety was apparent among the crew and everything appeared to be set for a successful landing. The aircraft appeared to one observer, namely Capt. MacKenzie, to be lower than he himself would have wished to be.

The picture thus presented by the evidence is of Capt. Jones making an unhurried and not unduly worried circuit to port, probably losing height as he did so but at all events not gaining any. He may or may not have turned slightly wide when turning on to final approach and had to correct, but if so the turn was gradual.

Some suggestion was made that the airport lighting at Blackbushe was such that it did not provide the pilot with adequate assistance. It was suggested that the fact that Capt. Jones may have had to correct his turn on to final approach, supports this view and emphasis was placed on the decision which has now been reached that cross bar lighting should be introduced and the approach lighting extended from 1,500 yd. to 3,000 yd.

Having heard all the evidence and the addresses of counsel it is perhaps sufficient to say that I am satisfied that the lighting of the airport on the evening in question was adequate and that it had no effect on the accident which occurred.

It is curious to note that the aircraft, when proceeding to take off, never asked for the Q.F.E., that is, the barometric pressure at Blackbushe, but was merely informed of the Q.N.H.—that is, the barometric pressure at Chatham. Although not strictly encouraged, it is common practice in a twin-engined aircraft when there are two altimeters to set the Q.F.E. on one and the Q.N.H. on the other. It may not be readily appreciated that any confusion between the two can prove serious. For example in this particular case, if in fact Capt. Jones had set the Q.N.H. on his altimeter and had forgotten that he had set the Q.N.H. instead of the Q.F.E., he could reasonably have supposed that his aircraft was about 300 ft. higher than in fact it was. In other words if Capt. Jones was judging his height from an altimeter on which he had set Q.N.H. instead of Q.F.E. he might have supposed that his height on turning on to final approach was 550 ft. instead of only 250 ft.

Unaware of Danger

It is strange that he obtained the Q.N.H. before starting his run but not the Q.F.E. and that he only asked for the Q.F.E. a little more than half a minute before the aircraft actually crashed. It would not be right in the absence of conclusive evidence to draw any firm deduction but I cannot help thinking that the absence of any

Banked Turnoffs Permit High Speed

Indianapolis Municipal Airport's new 7,300-ft. runway incorporates banked turnoffs said to permit pilots to clear the strip at speeds up to 63 mph. Civil Aeronautics Administration Technical Development Center installed the experimental turnoffs and also centerline flush lights leading down the runway to the turnoff and on the turnoff itself. Twelve white flush lights at 100-ft. intervals are on the runway, with blue flush lights on the turnoff. A flush blue light bar marks the intersection of runway and turnoff, and a flashing flush blue light warns the pilot at 500 ft. from the turnoff.

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Plush Vertol H-44C Demonstrated

Vertol brought its H-44C executive model tandem rotor helicopter to New York as part of a sales tour, demonstrated it to New York Airways, whose management is interested in a 15-passenger airline version (AW Dec. 16, p. 40). Executive model interior is pictured looking forward (right) and aft (left) with some seats removed. Capacity of the configuration is nine, sale price is around $300,000.

anxiety on board, the failure to attempt to gain height and the sudden request for Q.F.E. at so late a stage of this circuit tend to indicate that Capt. Jones thought his aircraft was a good deal higher than it was and that he may in fact have been relying on an altimeter on which the Q.N.H. had been set. One of the altimeters recovered from the aircraft was found to be set at 1020 millibars, a setting almost equivalent to the Q.N.H., but it was impossible to prove whether the altimeter in question was that in front of the captain's seat. Unless some such confusion took place, it is difficult to understand how this aircraft found itself so low at so great a distance from the threshold in all the circumstances of this flight.

Finally I have found it necessary to consider whether the crash might have been caused by a failure of the remaining engine. As to this I can only point to the fact that the aircraft evidently proceeded to circuit on the starboard engine and there is no indication in any message that Capt. Jones was disturbed at its performance. It would indeed be remarkable if it also had failed, nor is it likely that Capt. Jones would have let down the undercarriage, which was found locked in the down position after the crash, if he had not had confidence in his remaining engine. To my mind the possibility is virtually disposed of by the evidence of 2d Lt. Taylor and by the fact that examination of the site showed that the starboard engine had still been under considerable power at the time the engine hit the ground. Mr. Cameron-Douglas was able to establish that the starboard propeller cut through a tree root some 18 in. thick.

The evidence is, then, entirely clear that Bravo Oscar, after its turn to port, continued its circuit until it turned on to final approach. There is no evidence that it gained height and the evidence suggests that it lost it consistently during the circuit. There is no evidence of anxiety over the loss of height, and indeed the evidence indicates that Capt. Jones and his crew did not appreciate that any grave emergency had arisen. The request for the Q.F.E. at so late a stage of the circuit may indicate the sudden realization that all was not well. The fact that the flaps were not used is perhaps a further indication to the same effect. The sudden shudder described by 2d Lt. Taylor is the normal precursor of a stall. The fact that the tip of the port wing struck first is exactly what was to be expected in the case of an aircraft whose port engine was dead and which had lost flying speed. Everything points to the fact that Capt. Jones had no idea that the aircraft was so low; he made no attempt to climb and had his undercarriage down, thereby of course increasing the stalling speed, and stalled his aircraft some 1,200 yd. from the threshold of the runway he was seeking to reach.

Capt. Jones' Record

Before reaching a final decision it is necessary to consider Capt. Jones' record. It is all too easy to attribute blame to a man whose evidence is not available. Capt. Jones, who was described as a careful, responsible and above average pilot, was aged 34. He held a valid air transport pilot's license endorsed for Viking aircraft in Group 1. He had served some 1,000 hr. as an RAFVR pilot during the war and thereafter had served as a pilot with Hunting Air Travel. From 1950 to 1953 he had served with BEA, holding a senior commercial pilot's license endorsed, inter alia, for Viking Aircraft in Group 1. From 1953 until 1955 he had not flown but in 1955 he took a series of tests at the Ministry of Transport and Civil Aviation Flying Unit as a result of which he was graded "above average" and obtained a commercial pilot's license. On June 17, 1955, he joined Eagle Aviation Ltd. as a first officer, having converted his license into an airline transport pilot's license. On Aug. 1, 1955, he became a captain and was given a Viking command, having recently taken a type test to obtain the endorsement of his license to fly Vikings.

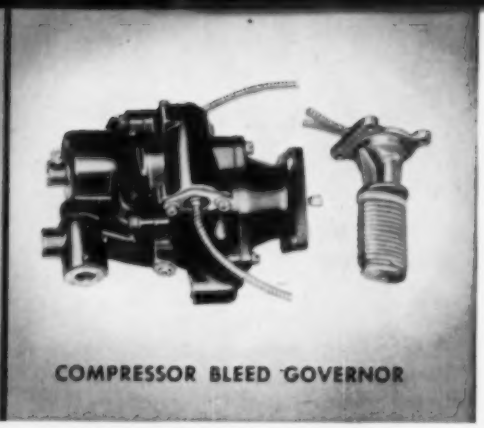
He had in all by May 1, 1957, flown a total of 6,800 hr., of which 4,800 had been flown with Viking aircraft, and of these some 1,586 with Eagle Aviation Ltd. He had made no less than 36 night landings in Viking aircraft at Blackbushe alone in the period of 18 months prior to this accident. First Officer Tunnington was also well qualified.

In the course of examining the record of Capt. Jones as a pilot, I found it necessary to consider in some detail the actual tests of ability to which he had been subjected since joining Eagle Aviation in 1955. These tests were of three sorts: The group rating test which he took July 20, 1955, to qualify for the inclusion of Viking aircraft in Group 1 of his license; tests for the purpose of renewing his instrument rating which he took Apr. 26, May 1, 1956, and on Apr. 9, 1957, and tests conducted from time to time to satisfy the requirements of Article 18(4) of the Air Navigation Order 1954 and Regulation 44 of the Air Navigation (General) Regulations 1954. Examination of the circumstances of some at any rate of these tests and of the records relating to them disclose certain defects.

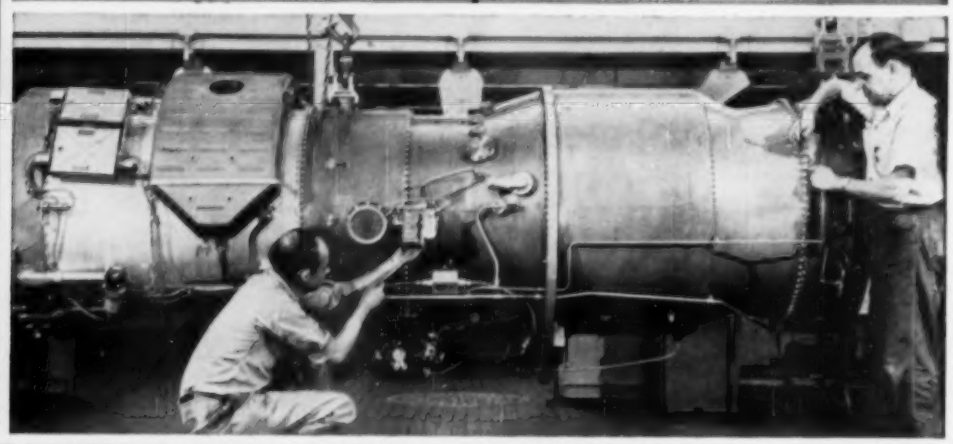
It is satisfactory to observe that Eagle Aviation Ltd. held a meeting Jan. 15, 1957—

Holley engine controls selected for JT4 engines on America's first jet airliner

BLEED PISTON ACTUATOR

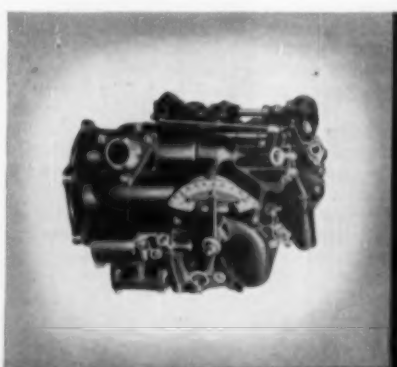


COMPRESSOR BLEED GOVERNOR



Powered by four JT4 Pratt & Whitney Aircraft engines, the Boeing 707-320 will carry 131 first class passengers from New York non-stop to the Continent in just over six hours! Each of these new engines, commercial counterparts to the J-75 which drives many of America's latest jet fighters, delivers up to 15,000 pounds of thrust. Ability to pack so much added power into a relatively small space is the result of designing engine components which will operate at higher efficiency, require less area and reduce over-all weight.

Holley Carburetor Company, working closely with Pratt & Whitney Aircraft engineers, carried out this exacting assignment on such vital engine components as: the compressor bleed governor, and the bleed governor actuator. For single and multi-engine military aircraft, the Holley main fuel control is a companion unit to the Holley governor and actuator.



For military applications, the Holley main fuel control (right) is a companion unit to the governor and actuator.

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that is, some 3½ months before this accident—at which certain decisions were taken with a view to tightening up the procedure under which tests of the second and third categories mentioned were carried out.

As I have said, Capt. Jones took his group rating test July 20, 1955, in order to qualify once again to fly Viking aircraft. This test was conducted at Blackbushe, Capt. Jones being tested or examined by Capt. Bright, one of his fellow pilots in the employment of Eagle Aviation Ltd. and designated by that company as a check pilot.

The requirements of the test are set out in the form known as C.A.528 issued by the MTCA. The test is of comprehensive nature and although the wording of the form is not as clear as could be desired it would appear (and I am told is generally understood) to require the candidate to make at least four takeoffs and landings—two by night and two by day, one landing in each case being made with the use of both engines and the others on one engine only. As completed by Capt. Bright, the form suggests that the test had been completed satisfactorily in all respects although it is observed that the two landings at night are given identical times.

Records Conflict

The records maintained at the control tower at Blackbushe record three flights only as follows:—

Takeoff 2032	Landing 2047
Takeoff 2055	Landing 2107
Takeoff 2109	Landing 2114 G.M.T.

The above times in accordance with the definition of night then imposed by the regulations were all to be classified as "day" landings. It follows that on the facts as recorded by the control tower only three takeoffs and landings were made, none of these being made at night as then defined by the regulations. If these facts are correct, it will be obvious that the regulations not having been complied with, the test was never properly completed.

I heard Capt. Bright in evidence and his statements on oath will be found in the transcript. Having read the transcript, he wrote a letter explaining that in completing the form he had mistaken B.S.T. for G.M.T. and having listened to his account of the test I was satisfied that he was not a witness on whom I could rely. It is curious that if Capt. Bright had made the mistake of confusing B.S.T. and G.M.T. —a mistake in itself somewhat surprising where an experienced pilot is completing a form to record a test of this nature—Capt. Jones should have made the same mistake, as appeared from his private log which was produced to me. In his letter Capt. Bright now suggests that he confused watch time with G.M.T., an explanation which I find no more convincing.

It may of course be true that the conditions resembled those at night but the fact remains that whatever the conditions of visibility it was admittedly not "night" as required by the regulations, and I am not satisfied that four takeoffs and landings were made or indeed that any landing was made in conditions of darkness with one engine inoperative. Having heard the evidence of Capt. Bright, Mr. Scarman, who appeared for Eagle Aviation Ltd., stated in open court that the company had decided to suspend him from acting as a check pilot. I observe from his letter that this suspension has since been removed.

Hercules Takes on 22 Tons

Commercial airfreighter version of the Lockheed C-130 Hercules will be loaded as demonstrated with this Air Force C-130. During tests at Marietta, Ga., 22 tons of palleted cargo were carried on conveyor into 4,300 cu. ft. cargo compartment and tied down in a matter of minutes, according to Lockheed. Turboprop permits straight-in truck-level loading.

On the strength of Capt. Bright's certificate that the test had been properly completed, Capt. Jones was granted the inclusion of Viking aircraft in Group 1 of his license. I expressed in the course of the inquiry some doubt as to whether in these circumstances he could be regarded as properly licensed to fly Vikings, but I am satisfied that the license granted must be regarded as legally valid even though its issue may have been influenced by inaccurate information.

Instrument Test

On Apr. 26, 1956, Capt. Jones took his instrument rating flight renewal test, being checked by Capt. Henderson, one of the company's check pilots authorized by the MTCA to check such tests on their behalf. This test was conducted in the course of a flight from Biarritz to Blackbushe. Part 1 of the test covers pre-flight action, takeoff, climbing and level flight—Part 2, airways procedure, and Part 3, the procedure on landing by instruments and on overshooting.

Capt. Jones failed in Parts 2 and 3 of this test and in particular when told in Part 3 to maintain 500 ft. he lost 250 ft. and allowed his air speed to drop off to 95 kt., so that he was in danger of stalling. His basic knowledge of instrument flying was classed as poor. Five days later he took the test again at Blackbushe, checked once more by Capt. Henderson, and on this occasion passed. It is, however, to be observed that Capt. Henderson made the following note: "Improvement on first attempt but needs to be watched." He then deleted the words "to be watched" and wrote instead "more practice." Despite the note made by Capt. Henderson on this occasion I was told that Capt. Jones had not received any special practice.

Capt. Jones took this test again on Apr. 9, 1957, being checked and passed by Capt. Bright in the course of a passenger-carrying flight from Blackbushe to Le Bourget and back. I find it difficult to believe that Part 3 of the test and in particular the procedure on overshooting could have been properly conducted on such a flight.

Regulation 44 to which I have referred prohibits the operator, that is to say in this case Eagle Aviation Ltd., from permitting any person to fly as a pilot unless his competence to act as such and to use the equipment provided in the aircraft to enable him to act in that capacity has been established either by:

- **Test administered** by operator within period of six months immediately preceding flight.
- **Two tests administered** by operator within period of 12 months immediately preceding flight, period between two tests being not less than four calendar months.

The precise nature of this test (usually called "the six monthly check") administered to test the pilot's competence is left to the operator, subject only to the fact that a liaison officer of the MTCA—in the case of Eagle Aviation Ltd. it is Mr. Chouffot—visits the various operators in his area to check their records, including the records of these particular tests, the nature of which is accordingly explained to him when, if he regards the test as in any way insufficient, I understand that he informs the operators accordingly.

Eagle Aviation has devised a form to record the completion of this test, which

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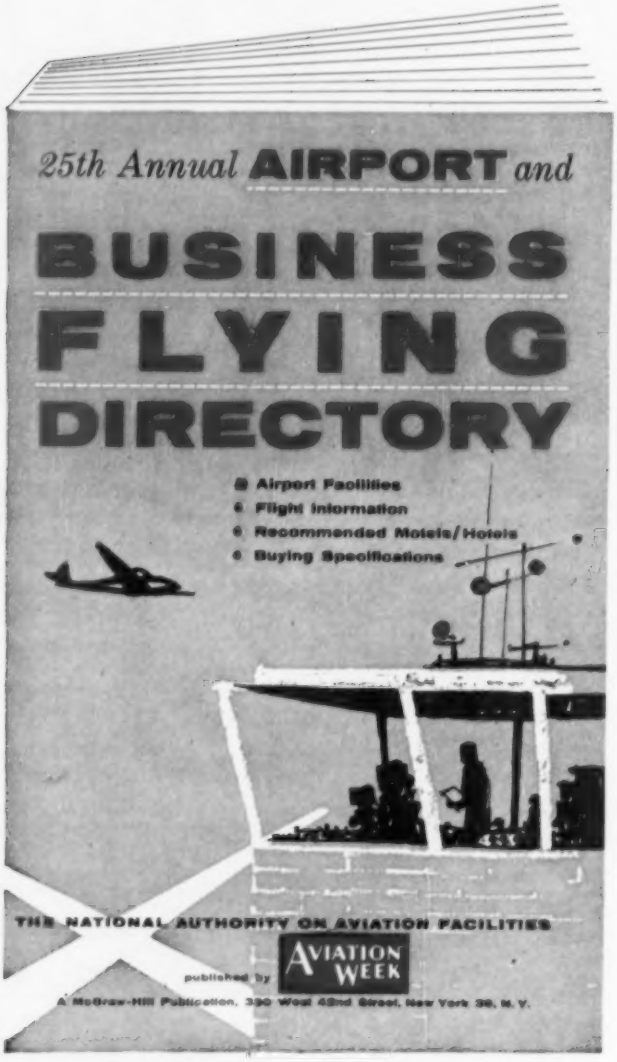

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form Mr. Chouffot said he regarded as satisfactory although he added that it might be improved by the insertion of more detail. In an example of this form as completed by Capt. Storm Clarke after a check on March 18, 1957, it will be observed that the second item is:

"Landing with engine inoperative by day/night" and the third:

"Simulated engine failure after takeoff by day/night."

Although the form provides the phrase day/night I was told that in fact little regard had been paid to whether the test was carried out by day or by night until the meeting on Jan. 1, 1957, at which it was agreed that alternate tests should be made by night. It is fair to add that an experienced pilot of BEA told me that the corporation did not consider that it made any difference whether such test was conducted by day or night, the procedure to be adopted, particularly in the case of the two items referred to, being identical in the case of day or night.

I have no hesitation in the light of all the evidence put before me in concluding that it does make a good deal of difference whether a pilot is required to land a twin-engined aircraft with one engine inoperative by day or by night. The weight of the evidence shows conclusively that it is on the whole more difficult at night and I do not suppose that any pilot would wish to make his first landing with one engine inoperative at night at a time when his aircraft was fully loaded and carrying passengers.

History of Checks

According to the evidence, Capt. Jones carried out "the six monthly check" on the following dates:

- **On July 15, 1955,** when he was checked by Capt. Bright—this test immediately preceding his promotion by the company to captain.
- **On Jan. 16-17, 1956,** when checked by Capt. Watkins.
- **On July 18, 1956,** when checked by Capt. Sauvage.
- **On Dec. 4, 1956,** when checked by Capt. Davis.
- **On March 18, 1957,** when checked by Capt. Storm Clarke.

It is necessary to comment on each of these tests:

The form as completed by Capt. Bright indicates that Capt. Jones had satisfactorily completed all the maneuvers involved. He eliminated the word "night" in regard to Items 2 and 3.

Capt. Watkins, the company's chief pilot, told me that this test was carried out with a view to testing Capt. Jones' efficiency and fitness for promotion to captain. Since, as I have said, the form requires a landing made with one engine inoperative I was surprised to find that on July 15, 1955, the Viking used made a flight from Blackbushe to Turnhouse (Edinburgh) and back and that passengers were carried in both directions, although on the flight north there were only two, both being employes of Eagle Aviation Ltd.

It is fair to Capt. Bright to record that his recollection of the flight was not unnaturally somewhat vague. He did, however, say that since Capt. Jones was only a first officer, the test was not such a grueling test as for a captain and that the landing would have been effected with one engine throttled back to simulate a one-engined landing and that it was the practice at that time to conduct the test even if carrying passengers. So far as the simulated engine failure was concerned, Capt. Bright explained that he would, after reaching a very safe height, have gradually reduced power on one engine so as to watch the pilot's reaction and whether he applied the necessary correction to hold the aircraft straight and level and then would have required him to go through the feathering drill without actually feathering the engine.

If the test was carried out as Capt. Bright described, it can have had only a very limited value and certainly would not justify its being treated as a promotion test from first officer to captain. Obviously a serious test including a true landing on one engine would not be carried out with passengers on board in the course of a normal flight. The fact that the chief pilot of this company appears to have thought that the very limited test carried out in fact had been of an entirely different nature serves to illustrate the attitude adopted toward these tests at this time.

On Jan. 16-17, 1956, the Viking aircraft in which Capt. Jones was tested by Capt. Watkins, who is the chief pilot of Eagle Aviation Ltd., flew from Blackbushe to Idris via Nice and from Idris to Blackbushe via Elmas and Marignane.

It is to be observed that on the form completed by Capt. Watkins, Items 2 and 4, the latter being "all maneuvers used in normal flight with one engine inoperative," were not completed and he himself agreed that a test which had not included Item 2 was not a proper test.

This test was made at Blackbushe by Capt. Sauvage on a special flight following a minor accident in the course of a landing made by Capt. Jones. He told me, and I accept, that Capt. Jones in the course of this special flight made by day landed a Viking on one engine perfectly satisfactorily and went through the other items of the normal test equally competently.

Although the usual form was not completed in regard to this test, contemporary records were made and I entirely accept that, the matter having been discussed with Capt. Watkins, it was properly agreed to treat it as a satisfactory six monthly check.

The test carried out by Capt. Davis on Dec. 4, 1956, was again obviously unsatisfactory. Items 2 and 4 are not completed. The aircraft was on the day in question flying from Blackbushe to Luqua via Marignane on a normal trooping flight which of course rendered it impractical to effect a single engined landing.

This, the most recent test, was carried out by Capt. Storm Clarke. I am satisfied that it was properly carried out in the course of a special flight at Blackbushe shortly after mid-day.

Summary of Evidence

It is desirable to sum up the effect of the evidence as to the group rating and instrument rating tests and the captain's six-monthly tests. In my opinion they show the following:

There is no satisfactory evidence that in the course of his employment by Eagle Aviation Ltd. Capt. Jones was ever required to land an aircraft at night on one engine.

He did make such a landing on at least two occasions by day, namely with Capt. Sauvage on July 18, 1956, and with Capt. Storm Clarke on March 14, 1957. He may have made such a landing with Capt. Bright on July 15, 1955. So far as the other six-monthly tests are concerned, namely those carried out by Capts. Bright, Watkins and Davis, I am satisfied that they did not amount to satisfactory tests to satisfy the regulations. It is, as I have said, reassuring to observe that Eagle Aviation Ltd. had started to put its house in order a considerable time before May, 1957.

So far as the instrument rating tests are concerned, I have grave doubt as to whether that conducted in April, 1957, by

Khrushchev and Guests Inspect Il-18

Sergei Ilyushin describes the Il-18 Moscow he designed (AW Oct. 7, p. 43) to Soviet leader Nikita S. Khruschchev (right), other Soviet and foreign officials who viewed new transports.

Capt. Bright can have been a proper test.

I am satisfied that the group rating test that this captain conducted in July, 1955, under Capt. Bright did not comply with the regulations and I am not satisfied that it comprised a landing with one engine inoperative in night conditions.

I thought it right in the light of the facts disclosed to hear the evidence of Mr. Chouffot as to the supervision he exercises over the records of operators. So far as the group rating test is concerned, the test is strictly a personal matter between the captain, the examiner and the MTCA and no form or copy of the form submitted is retained by the company whose pilot is applying for the type addition to his license. There is accordingly no record for Mr. Chouffot to inspect.

Again, the instrument rating renewal test is primarily a matter between the pilot his examiner and the MTCA.

In the case of the six-monthly test, however, this is essentially the responsibility of the operator and Mr. Chouffot told me that in the course of his visits, which he stated that he normally made every six months, he makes a spot check by naming two or three pilots and then asking for their records. He had not found any significant fault in the case of those he had examined in the offices of Eagle Aviation Ltd. but had not seen those of Capt. Jones. He agreed that if he had seen a form on which Item 2 had not been completed he would have regarded that as a significant fault. It must be understood that Mr. Chouffot covers a large area including a number of operators and cannot check everything. It so happened that in the case of Eagle Aviation Ltd. Mr. Chouffot, when asked as to his last visit, informed me that it was in February, 1957, his previous visiting having taken place exactly 12 months before.

I have considered whether any weight is to be attributed to the deficiencies referred to in the tests carried out by Capt. Jones in connection with the circumstances of this accident and in particular the fact that he had had no recent experience of making a night landing with one engine inoperative. I have come to the conclusion that I would not be justified in doing so. Capt. Jones was a very experienced pilot, particularly in Viking aircraft, and very experienced in making night landings in normal circumstances. The fact that he may in the course of tests many months before have fallen below standard is common in the experience of any pilot and must be viewed in proportion and against the background of his general experience and efficiency. He was described to me by Capt. Sauvage, who proved a good witness, as a very thorough captain in his application to his duties —a deliberate sort of man who kept himself rather aloof from others and generally did a very good job on the ground as well as in the air—a very reliable man.

I think I am accordingly justified in regarding the matters disclosed in regard to the various tests as matters upon which I should consider recommendations rather than as having any necessary connection with the circumstances of this particular accident.

My answers to the questions asked by Her Majesty's Attorney-General are:

• **Did aircraft** have valid certificate of airworthiness and current certificate of maintenance at time of accident?
Yes.

• **Was crew properly** licensed and adequately experienced for proposed flight?
Yes.

• **Was aircraft loaded** and trimmed within specified limits set out in certificate of airworthiness?
Yes.

• **Had aircraft** been maintained in accordance with approved maintenance schedule?
Yes.

• **What was cause** of accident?
Failure of Capt. Jones to maintain height and a safe flying speed when approaching to land on one engine after failure (or suspected failure) of port engine due to some cause which cannot be ascertained.

• **Was loss of aircraft** caused or contributed to by wrongful act or default of any person or party?
No. I think error made by Capt. Jones was error of skill and judgment.

Commissioner's Recommendations

The defects in regard to the various tests to which Capt. Jones was put clearly require consideration with a view to improvement and to insuring that the regulations are properly complied with.

Various suggestions were made by counsel with particular reference to the captain's six-monthly checks. It was suggested that any application for renewal of the pilot's license should be accompanied by some form of record of the completion of the six-monthly check, also that not all tests or checks should be carried out under examination by a captain in the same company as the pilot and that the MTCA should lay down in detail the precise nature of the test required to comply with Regulation 44 and should insist that testing at night is included. It was also proposed that the MTCA should inspect the records of all pilots at regular intervals and that regulations should forbid the carrying out of tests in the course of passenger flights.

To these suggestions counsel for the MTCA raised various objections. It was said that the efficient conduct of operating companies was best left to themselves subject to gentle prodding from time to time toward a higher standard from liaison officials such as Mr. Chouffot. It was pointed out that more regulations and more forms, while they may require more civil servants to file, administer and enforce, do not necessarily lead to greater efficiency. Emphasis was placed on the fact that it is in the interests of operating companies themselves to observe the regulations and maintain the highest standards of efficiency.

While I would hesitate to recommend any action which would involve more inspectors, or more forms, I cannot help thinking that the argument that everything should be left to the operator is too optimistic. The fact remains that in this accident 34 people were killed. While it may have had nothing to do with the accident, it remains true that the pilot had not carried out properly the test required to fit him to fly this aircraft, had not at any rate in the last two years landed a twin-engined aircraft with one engine inoperative "at night," the very maneuver which he was

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required to perform on this occasion with a full load of passengers. Further, the various six-monthly checks which he should have undergone and which should have included landing with one engine inoperative had not in three cases out of five been done so in fact. It is also doubtful to what extent he had been properly practised in instrument flying.

Test Suggestions

It may be helpful if, without making any more detailed recommendation, I make a few suggestions for consideration in regard to the three types of test:

• **Group rating test**—This is an important test because depending on its result the pilot or candidate for qualification may or may not become licensed to fly a type of aircraft. At present the candidate is examined by any pilot who has himself the qualification for which the candidate is applying, and the only parties involved are the MTCA and the examining and candidate pilots. On completion of the test the form C. A. 528 is transmitted to the Ministry and, save for providing the aircraft for the test and perhaps paying for the fuel consumed, the operating company which employs the examining and/or candidate pilots is not directly concerned.

Unless the Ministry, through its officials, is to conduct the test or those pilots allowed to conduct it are to be selected by the Ministry, the responsibility must be placed upon the operating companies. Just as certain operating companies are authorized to carry out instrument rating tests through approved pilots, so I suggest they should be authorized to carry out this test, the pilots whom they select to examine being approved by the Ministry for the purpose. If this responsibility were placed on the operators and if any serious departure from the regulations was visited by withdrawal from the operating company of its qualification, I cannot help thinking that a very much higher standard would be enforced by the companies in question since removal of the qualification would involve serious practical disadvantages.

So far as the form used is concerned, it is far from clear. It should specify in terms the number of takeoffs and landings involved and require the times of each, whether by day or by night, to be stated.

• **Instrument rating renewal test**—We suggest that steps be taken to insure that Part 3 of the test is only carried out in the course of a special flight.

• **Six-monthly check**—Again insofar as this involves landing with one engine inoperative, insistence should be placed upon it being conducted on a special flight.

I see no need for the MTCA to lay down the matters which ought to be comprised in the test; these are of course well known to operators and can be checked by the Ministry's liaison officers. I am, however, strongly of opinion that at least every other test ought to include a landing with one engine inoperative at night. It is desirable that the checking by the Ministry's liaison officer of the records of these tests should be facilitated by the operating companies. The present system by which Mr. Chouffot calls for the forms in relation to two or three pilots as a spot check may mean that the records of some pilots are never checked at all and the unsatisfactory character of some of the tests may never be detected. It would not be difficult, I suggest, to insist, that each operating company should provide a statement of the test as laid down and maintain in tabular form a record of the tests as completed by each pilot. This would enable the liaison officer to observe at a glance the broad position and he could then, if he thought necessary, send for the more detailed records of individual tests.

Alternatively, operating companies could be required to provide a certificate as to the carrying out of the tests confirming that all pilots had been tested in accordance with the regulations, any exceptions being stated. I should think that most of these matters would not require further forms or regulations but could be dealt with by letters of request from the Ministry to the operating companies. None would seem to involve much, if any, additional labor or time in the Ministry, and I imagine that a procedure which would require operating companies to keep a close eye on these tests and insure their proper conduct would be welcomed by most companies and certainly no company operating trooping contracts would be likely to withhold its cooperation.

Finally I should refer to a point which arises from 2d Lt. Taylor's evidence. He states: "No instructions were given concerning emergency exits, their location or manipulation by any member of the crew."

I should at once make it clear that the above sentence is not to be regarded as any criticism of Eagle Aviation Ltd. since there is no obligation to give such instructions. My assessors, however, inform me that it is the practice of some airlines to do so either verbally or by means of a safety instruction pamphlet. It is to be observed that in this case 2d Lt. Taylor had noticed that the window exit next to him was labeled "Emergency Exit—Push" and had done so and was followed by a few other passengers. It is a matter for speculation whether, if instructions had been given, more of the other passengers might have acted in the same way. I can only suggest that the question of whether instructions should be given and if so, in what form, is deserving of consideration.

H. J. PHILLIMORE

Coast Guard Favors Ditched Plane Signal

Honolulu—All overseas aircraft should be equipped with automatic radio emergency signal devices, according to Capt. D. B. MacDiarmid, chief of operations, 14th Coast Guard Headquarters here.

Recent search operations for Pan American's lost clipper (AW Nov. 18, p. 41), MacDiarmid said, might have been aided by such a device which would have sounded a signal as soon as the plane's wings were inundated.

The Coast Guard officer said a suitable device is available, weighs about 2 lb. and costs about $500. He described it as a transistor-powered small radio, installed in the wing and held in place with soluble plugs which melt when the wing goes into the water. Then the radio floats to the surface, raises an antenna and emits its signal.

Bolt Fouled Aileron, Caused Viscount Crash

London—Metal fatigue in a small bolt in the flap operating mechanism was blamed in a public inquiry here for the crash of a Vickers Viscount 701 in which 22 persons lost their lives at Manchester Airport last Mar. 14.

Government investigators said primary failure occurred in the bottom fitting on number two flap when a bolt fractured (AW Mar. 25 p. 45). When the bolt broke as the Viscount was making its landing approach at Manchester, the flap unit was able to pivot upwards sufficiently so that it snagged on the wire operating the aileron and locked it. The pilot was unable to overcome the effect of the jammed aileron.

"The villain of the piece was unquestionably the nine-sixteenth bolt, because that was the main stress-carrying bolt, and if that had not failed all would have been well," a government spokesman told the court. "I have no doubt you will be satisfied its failure was initiated by what is known as fatigue."

Tests showed, he said, that if the bolt was not bedded flatly against the surface on which it was pressed but at a slight angle and subject to alternative loads, fatigue was likely to occur sooner.

"This bolt, in fact was not fitting fairly on its seating," he said.

After the accident, all bolts attached to the bottom of flaps on Viscount aircraft were removed and replaced. Over eight hundred bolts from Viscount flaps were examined. In a small but "significant" percentage there was evidence of fatigue cracking, he reported.

He said that one possibly significant finding was that there was a higher percentage of fatigue cracks in bolts which had been fitted after it was decided to fit a stronger chain to operate the flaps. Other parts of the structure had been strengthened at that time, with the nine-sixteenths bolt replacing the half-inch main bolts which previously had held the bottom part of the flap unit.

"There is a suggestion that the application of this modification might in some way have resulted in a misalignment of the bolts, which would have accelerated fatigue," the government spokesman said.

Viscounts since have been modified to prevent a similar accident.

The chief engineer of British European Airways, Ivan Murray, told the inquiry that the aircraft which crashed was one of BEA's "older machines."

He said the aircraft concerned had made 4,553 landings, many of them by trainee pilots. He declined to comment on whether the number of landings had been a contributing factor.

Pay Of College Teachers... Where The Russians Are The Capitalists

This editorial deals with a simple question about college faculty salaries: Which country pays its teachers better, Russia or the United States? It's a good question, with a sadly embarrassing answer.

That American college and university teachers are underpaid is not a novel observation. But what has happened to the economic status of their profession can be put in more candid terms. **As far as financial incentives are concerned, we have virtually socialized the academic profession.** Teaching has become such a poorly paid career, with so little prospect of material reward for outstanding performance, that it simply does not attract enough highly qualified young men and women.

Ironically, the Soviet Union has deliberately and successfully used capitalist incentives to improve its educational system. Although the Russians show an utter disregard of civil liberties, they pay their teachers well and confer on them all the prestige and privileges the Soviet society can offer. Russian professors, together with party officials and scientists, have become the privileged upper class of a supposedly classless society.

Incentives To Be A Teacher

To be a college teacher requires high intellectual competence and long, sometimes costly, formal training. Aside from the appeal of academic life, what incentive does college teaching offer bright young men and women?

In the U. S., the average faculty salary is little more than the average income of industrial workers. According to the National Education Association, the average faculty salary is about $5,240. College instructors receive $4,100, associate professors $5,730 and full professors $7,100. The average income of U. S. factory workers in 1956 was $4,580.

Actually, workers in many industries — steel, automobile and petroleum, for example—earn more on the average than college teachers. And skilled workers often earn more than full professors at some of our colleges and universities.

In Russia, on the other hand, the young Soviet graduate can see that it pays — and pays very well — to choose teaching as a career. The head of a department in a Russian university can command a salary of about 6,000 rubles a month.* This is about eight times the income of the average Russian worker, who earns 750 rubles a month.

The Russian professor comes off very well in terms of what his income will buy. It has been estimated that, based on Soviet consumption patterns, 6,000 rubles a month is worth about $7,200 a year — or higher than the average professor's salary in the U. S. Of course, it is difficult to compare living standards in two countries as different as the U. S. and Russia. But particularly in the field of science — where the salaries can run to 15,000 or more rubles a month — it is clear that the Soviet professor enjoys a higher real income than that offered his American counterpart by a much more prosperous economy.

Incentives To Be A *GOOD* Teacher

Russia also offers much higher premiums than the U. S. to those who attain distinction in teaching. Teachers at the university level earn significantly more than teachers in high schools, and university instructors can look forward to a sharply progressive rise in earning power as they

* *Soviet Education for Science and Technology* by Alexander Korol of the M.I.T. Center for International Studies.

How Faculty Salaries Compare With Industrial Wages

(Worker's Wage In Each Country = 100)

*Sources: Center for International Studies, M.I.T.; National Education Association; McGraw-Hill Department of Economics

advance to higher positions. The spread between the income of a full professor and the lowest academic position is greater than fifteen to one. In addition, full professors can earn a healthy bonus if they are elected to membership in the Russian Academy of Sciences.

In the U. S., by contrast, full professors on the average earn less than twice as much as beginning instructors. And many college professors earn less than public school teachers in large cities. Even a full professor's pay does not compare with earnings in other professions or in positions in industry requiring similar training. The point was well summarized in a recent speech by Marion B. Folsom, Secretary of Health, Education and Welfare: "It is nothing short of a national disgrace that we are discouraging people who want to teach by offering salaries that are far below the levels justified by their training and far below the levels which others are willing to pay."

Our colleges and universities, as well as our teachers, find themselves in a serious predicament. Faced with a shortage of both funds and teachers, they cannot reward distinguished performances. Limited resources for salary increases have gone predominantly to the lower ranks, so that an adequate number of teachers could be retained. Meanwhile, potentially fine teachers are being siphoned off into better paid occupations.

The shabby treatment of our teachers threatens to undermine, not only our educational standards, but our free enterprise system itself. There is the recent example of a liberal arts college which discovered that five of its graduating seniors were being offered starting salaries higher than those paid any of their professors. It would be surprising if experiences like this did not place a strain on the enthusiasm with which these professors deal with some key aspects of American capitalism.

Also important is the role education is playing in the cold war with the Soviet Union. The Russians have made great strides in raising the quality of their education — particularly in science and engineering. Both the number and the technical calibre of their graduates are impressive, as recent Soviet achievements testify. These successes owe much to the generous economic treatment the Russians have given their teaching profession.

A Standard For Faculty Pay

Earlier editorials in this series have outlined various ways American business can help relieve the financial plight of our colleges and universities. They have suggested that private contributions to higher education should average at least $400 million a year over the next ten years if faculty salaries are to be raised to adequate levels and our colleges are to be able to meet increasing operating costs.

Another standard for raising faculty salaries proposed by an American businessman is this: "When a teacher's income gets up to a point where you will suggest to your boy that he ought to give some thought to teaching as a profession, then we may be approaching the right figure."

Russia clearly has set her teaching salaries well above the "right" figure. We are nowhere near it. What this adds up to is that the Communists — not we — have become the shrewd capitalists in the vital field of education.

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nation-wide developments. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.

Donald C. McGraw

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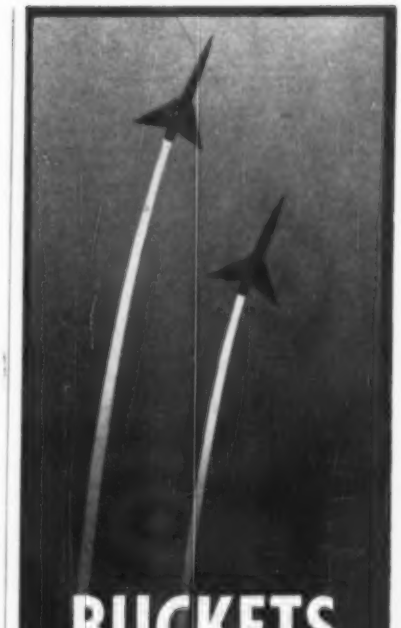

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LETTERS

Best Analysis

Congratulations on an excellent job for your two-part report on Countermeasures. (AW Nov. 18, p. 50; Nov. 25, p. 102.) As an unclassified document, it is the best analysis I have seen in a long time.

DR. JOSEPH H. VOGELMAN
Technical Director
Directorate of Communications
Rome Air Development Center

(Prior to assuming present post, Dr. Vogelman was technical director of RADC's Intelligence & Electronic Warfare Laboratory.—Ed.)

Similar Records

The article on the British Orpheus engine, written by Dave Anderton for your Nov. 25 issue (p. 51), is as excellent and informative as it is thorough. Congratulations are due Dave for a superior reporting job.

We would like to question, however, the following paragraph in the article on p. 51:

"Bristol's detail design work and the first running of the engine are separated in time by less than a year, which must be some sort of a record for a contemporary turbojet."

The Westinghouse Aviation Gas Turbine Division established a similar (if not better) mark when the J54 went on test March 17, 1955—just 11¼ months after the engine detail design had begun on April 1, 1954. Rolls-Royce, too, we believe, performed admirably when their RA-14 Avon reached test less than a year after detail design began. We do not question Bristol's fine accomplishment. We *do* question any claim to uniqueness.

In the interest of accurate detail, we thought you would appreciate having this information for future articles of this nature.

BRIAN R. CARTER, Manager
Sales Promotion
Aviation Gas Turbine Division
Westinghouse Electric Corp.
Kansas City, Mo.

Engineers Upheld

My experience in aircraft has always been from the sidelines: 17 months with 8th Air Force WAF; two years secretary to engineers —Convair, Ft. Worth, Tex.; six years wife of a man dedicated to safety in aircraft. May I offer my opinions on the subject of the Third Crew Member in the cockpit argument?

The professional flight engineer does not pretend to know the captain's job. Five out of six, however, are educated in the aircraft from the ground up, both as A&E and private flyer. The professional flight engineer concentrates upon the safety and performance of the aircraft.

This concentration has, in part, been responsible for the excellent safety records enjoyed by most commercial airlines companies today.

A pilot-engineer trainee might not take the same interest, inasmuch as his position would only be a stepping stone. Therefore, what is to keep him from becoming frustrated, as time wears on, and very uninterested in the responsibility at the flight engineer's stations?

The captain, copilot and flight engineer have proven their ability to work as a team. Most pilots have respect for the pro flight engineer, and know it takes more than average interest of a trainee to accomplish the safety job required.

Why all this pushing on the part of the Air Line Pilots Assn. against the professional engineer? Will it really save a company money to do away with the professional flight engineer if they sacrifice safety and, in turn, passengers?

A FLIGHT ENGINEER'S WIFE
Kansas City, Mo.

Aviation Week welcomes the opinion of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

FEIA Membership

In regard to your Nov. 11 issue of AVIATION WEEK, under the "Airline Observer" column (p. 43), I wish to help set the record straight regarding the Flight Engineers' jurisdictional election being held at United Air Lines.

You stated that the Flight Engineers' International Assn. (AFL-CIO affiliate) represents 648 flight engineers or about 90% of all U. S. engineer crew members.

No doubt this was a misprint and should read 2,648. Just recently Western Air Lines, Flying Tiger Line and California Eastern Aviation voted to be represented by the FEIA. These three newcomers plus the expansion within the FEIA have increased our membership to approximately 3,000.

I would, and I know many more F/E subscribers to AVIATION WEEK would, appreciate this error being corrected in a later issue of your magazine.

F/E RAY O'SHEA, UAL
DENVER, COLO.

(AVIATION WEEK inadvertently dropped the figure "2"—and FEIA membership now does approximate 3,000.—Ed.)

Civil Service Critic

An authoritative, respected and well-read journal like AVIATION WEEK could perform a signal service to our country by investigating and exposing the following:

Pre-Sputnick press releases from Washington stated that many thousands of "non-essential" Civil Service personnel with Army, Navy, and Air Force were to be released as an economy measure.

In fact—with lashings of additional "crash" funds at their disposal, Civil Service mass hirings are now under way. The Empire Builders are at work again!

There is not a single missile and/or satellite activity throughout the country, Army, Navy or Air Force, which is not infested with hordes of underworked, overpaid Civil Service "scientific, engineering and technical aide" personnel. Their specialty (?)—paper pushing, writing "classified" memorandums to each other and anyone else they can antagonize, insisting on time-wasting bureaucratic procedures and, in general, doing a first class job causing serious delays on many costly and important projects (Hoover Report 1955-56).

We do not refer to those skilled artisans carrying out essential maintenance and construction around the bases, nor to the very few top-flight, competent and probably underpaid government personnel.

We would inquire why, at any time, does our Administration have working for it thousands of "non-essential" employes? Why were these people recruited in the first place and what, if any, system was used in selecting them?

It is well known in industry that very few applicants who apply for these Civil Service "openings" would meet the rather stringent academic and experience backgrounds demanded in private industry.

Incidentally, and contrary to the propaganda put out by certain pressure groups, Civil Service salaries—considering the general type of personnel hired—are extremely good and, what with seemingly limitless "time off" privileges, vacation and sick leave and other fringe benefits, are far better than those offered in private industry. We refer to that group enjoying salaries in the $5,000-$9,000 per annum group.

"Firming-up" and "concretizing" (Civil Service gobbledygook for "finally"), the average, so-called "scientific, engineering and technical aide" personnel presently employed by Civil Service at most of our missile and/or satellite bases never had it so good!

EL PASO TAXPAYER

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Correct Information

To set the record straight, we should like to state that in the article, "Pilot's Picture Tube Display Test Flown," by Richard Sweeney (AW Oct. 21, p. 34), DuMont Laboratories was incorrectly named as having developed the display generator for the test bed hardware. The correct information is that Kaiser Aircraft & Electronics developed the display generator and the "memory" sphere, as well as the thin cathode-ray tube and other electronic components of the system.

Thank you for your cooperation in this matter.

R. M. WATT, JR., MGR.
Kaiser Aircraft & Electronics
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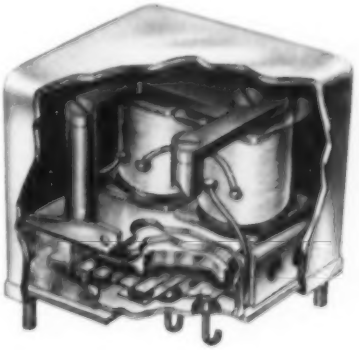

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